

20<sup>th</sup> annual Congress of the  
**EUROPEAN COLLEGE OF SPORT SCIENCE**

24<sup>th</sup> - 27<sup>th</sup> June 2015, Malmö – Sweden

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# Welcome

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On behalf of the Department of Sport Science, Malmö University, Sweden, the Department of Health Sciences, Lund University, Sweden, and the Department of Nutrition, Exercise and Sport, University of Copenhagen, Denmark, it is our pleasure to invite you to attend the 20th Annual Congress of the European College of Sport Science – ECSS Malmö 2015.

The multidisciplinary ECSS Congress will be celebrating its 20th anniversary. The 2015 congress theme of Sustainable Sport will permeate the academic programme as well as the arrangements: the three universities co-hosting the event all emphasize sustainability

In education and research, and will work together with the City of Malmö, a fair trade city, to make ECSS 2015 a sustainable sport congress.

The ECSS congress especially emphasises exchange of knowledge through oral and mini-oral presentations, and we are convinced that all attendees will find interesting topics and participate in creating new knowledge within the broad field of Sport Sciences. Once again, the Young Investigators Award will be one of the highlights of the congress.

We look forward to seeing you all in Malmö and the Öresund Region, an area with tremendous social, political, and economic potential in the area of sustainability. Together, we will create an outstanding congress, where we shall develop the broad perspective of sustainable sport.

*Susanna Hedenborg & Aage Radman, Congress Presidents*



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# Wednesday, June 24th, 2015

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13:00 - 14:00

## Mini-Orals

### MO-PM01 Training & Testing

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#### RISK FACTORS FOR ANKLE SPRAINS SUSTAINED DURING NETBALL PARTICIPATION

Attenborough, A.S.1, Sinclair, P.J.1, Sharp, T.1, Stuelcken, M.2, Greene, A.3, Smith, R.M.1, Hiller, C.E.1

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**Introduction** Netball is a sport that places high physical demands on players, requiring them to perform jumping, bounding, pivoting and cutting manoeuvres at high speed. Ankle injuries account for approximately 40% of all netball injuries, with sprains being the most diagnosed ankle injury (Fong et al., 2007). The identification of risk factors that predict the occurrence of ankle sprains within netball is necessary for the development of future prevention programs. **Methods** Ninety-six netball players were assessed prior to the netball season for the following outcome variables; vertical jump, perceived ankle instability, previous sprain history, arthrometry inversion-eversion angles, star excursion balance test (SEBT) reach distances, number of foot lifts during unilateral stance and demi-pointe balance test. Participants were followed for one netball season and ankle sprains were determined using a time-loss injury definition. A forward sequential logistic regression model determined outcome variable risk factor status. **Results** Eleven ankle sprains were reported by eleven players. Three outcome variables made a statistically unique contribution to ankle sprain risk; a posterior-medial reach distance of  $\leq 77.5\%$  of leg length in the SEBT (OR=3.87, 95% CI=0.90-16.60), an inversion-eversion arthrometry angle of  $\geq 36.8$  degrees (OR=3.86, 95% CI=0.95-15.64) and an inability to maintain unilateral static balance during the demi-pointe balance test (OR=3.46, 95% CI = 0.87-13.80). Possessing all three risk factors would render a player 52 times more likely to sustain an ankle sprain. **Discussion** The posterior-medial reach distance, which is considered to be the most representative of overall SEBT performance (Hertel et al., 2006), was found to be a risk factor for ankle sprain. Research to create a risk profile screening tool for netball injuries has questioned the inclusion of the SEBT in the assessment (Reid et al., 2014). The current study refutes this and suggests that the posterior-medial direction of the SEBT should remain within the proposed screening tool. Two of the three identified risk factors were balance tests that could be easily administered during preseason preparations for the identification of 'at-risk' players. Interestingly, a previous ankle sprain and the presence of perceived ankle instability had no association with the ankle sprains sustained by the netball players. **References** Fong DT, Hong Y, Chan LK, Yung P, Chan KM (2007) *Sp Med*, 37(1), 73-94 Hertel J, Braham R, Hale S, Olmsted-Kramer L (2006) *J Orthop Sports Phys Ther*, 36(3), 131-7 Reid D, Vanweerd R, Larmer P, Kingstone R (2014) *J Sci Med Sport*, DOI:10.1016/j.jsams.2014.05.008 Contact aatt4376@uni.sydney.edu.au

#### EFFECTS OF UNSPECIFIC ENDURANCE EXERCISE ON SPECIFIC SPRINT PERFORMANCE IN INLINE SPEED SKATING

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*German Sports University*

**Introduction:** A highly developed aerobic performance level enables inline speed skaters (ISS) to sustain a high average of speed (40 km-h<sup>-1</sup>) during competition. Since the appropriate period to develop this ability is the winter preseason, due to the weather sport-specific training is not possible. A previous study has shown that unspecific endurance training improves specific endurance capacity (Hildebrand et al. 2014). Generally, a high aerobic capacity is negatively correlated with the sprint performance. However, to be competitive and successful, ISS also require power and swiftness to generate most effective sprints for the mass start, tactical attacks and the finish. Hence, we investigated the influence of nonspecific endurance training (cycling, running) on ISS' sport specific sprint performance. **Methods:** 14 high level ISS (7 male, 7 female, 24±8 yr, 175.4±9.7 cm, 67.5±11.2 kg) were randomly divided in two groups (running, cycling). Training was completed at 60% of VO<sub>2</sub>max over 7 weeks with 2 sessions per week (81-90 min) each on treadmill or cycle ergometer, respectively. Before and after the training intervention all subjects performed a specific (300 m) and nonspecific (30 s cycling or running) all-out sprint test. To determine the production rate of blood lactate (BLA) and glucose (BGL) one arterialized blood sample (20 µl) was taken at rest, as well as ten at one minute intervals after the sprint test. **Results:** The production rate of BLA decreased significantly (p=0.02) after the specific sprint test without any group effect. The production rate of BGL only showed a significant decrease (p=0.04) after the specific sprint test in the running group. However, the sport-specific sprint performance remained unchanged (29.4±2.7s, 29.6±3.7s). No significant changes were found from pre to post for the production rates after the unspecific sprint tests. **Conclusion:** Since the study was conducted during the preseason, the absent loss of sprint performance can be considered as positive, indicating that nonspecific training at 60% of VO<sub>2</sub>max stabilises ISS' sprint performance. Moreover, the decreased production rate for BLA enables the athletes to recover faster from high intensity sprints. The lower production rate of BGL for all athletes who trained in the running group should be considered for optimal endurance training. The results suggest this type of unspecific training presents a greater stimulus for the sport-specific fat metabolism than cycling, resulting in a more economic energy supply (Jeukendrup, 2002). **References:** Hildebrand C, Abel T, Hesse C, Claßen S, Strüder HK. (2014). 19th. Annual congress of the European College of Sport Science, Book of Abstracts, 246. Jeukendrup A. (2002). *Ann N Y Acad Sci*, 976, 217-35. Contact: c.stangier@dshs-koeln.de

## THE IMPACT OF DATA AVERAGING STRATEGIES ON VO<sub>2</sub>MAX

Martin-Rincon, M.1, Perez-Valera, M.1, Rodríguez-Afonso, K., Cherouveim, E., Curtelin, D., Losa-Reyna, J., Sanchez Torres-Peralta, R., Ponce, J.G., Morales, D., Dorado, C., De Pablos, P., Calbet, J.A.

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**Introduction** Given the high breath-to-breath variability of respiratory variables, it is considered that including a greater number of breaths in averaging intervals will reduce variability between tests. However, the VO<sub>2</sub>max is only achieved during a short interval and therefore long averaging intervals may result in underestimation of the actual VO<sub>2</sub>max. The aim of the study was to determine the impact of the number of breaths included in the averaging interval on the reliability of VO<sub>2</sub>max measurements and on the absolute VO<sub>2</sub>max value. **Methods** After familiarisation, 40 men and 22 women performed two incremental exercise (IE) tests to exhaustion in two weeks. Five different IE protocols were used: ramp (15 or 20W/min) and steps (25, 30 or 35 W/2min) (Lode, Excalibur, Netherlands), all adjusted to reach a minimal IE duration of at least 6 min. Respiratory variables were measured breath-by-breath (Vmax N29; SensorMedics). The last two minutes of IE were analysed to determine the VO<sub>2</sub>max using rolling averages including from 6 to 60 breaths. The individual coefficient of variation (CV) was determined for each averaging strategy. **Results** The highest mean CV value (5.93%, range:0.04-21.8%) was obtained with 6 breaths and the lowest with 21 (4.85 %, range: 0-23.5%, n=61). For more than 21 breaths the CV increased progressively with the number of breaths. No significant differences in CVs were observed between sexes, protocol or fitness status. The averaging strategy had a major influence on the imputed VO<sub>2</sub>max values. VO<sub>2</sub>max values were higher, the lower the averaging interval (P<0.05). For 6, 21 and 60 breaths averages the mean VO<sub>2</sub>max was 2.89±0.74 (±SD), 2.72±0.70, and 2.63±0.69 l/min, respectively (P<0.05). In percentage, the difference in imputed VO<sub>2</sub>max between 6 and 21 breaths was 6.5%. The following equation can be used to determine the impact of the averaging strategy on VO<sub>2</sub>max:  $A=0.3947 + 0.863*B - 0.0511*B^2 + 0.00168*B^3 - 0.00002518*B^4 + 0.000001504*B^5$  (R<sup>2</sup>=0.999, P<0.001) Where A is the correction factor (in %), and B is the number of breaths above 6. For example, to calculate the difference in VO<sub>2</sub>max between one test having 6 and another 20 breaths, B=14, and the calculated A=6.04%. **Discussion and conclusions** The number of breaths included in the averaging interval when measuring VO<sub>2</sub>max with metabolic carts has a major impact on the absolute VO<sub>2</sub>max values, which may completely distort the assessment. However, the impact on variability is small. Our data indicate that the highest reliability is achieved by using 21 breaths averaging intervals. **Acknowledgements** ISCIII Spain (PI14/01509). **Contact** marcos.martinrincon@gmail.com

## INFLUENCE OF A DIFFERENT FAMILIARISATION ON TIME TRIAL PACING IN NOVICE PARTICIPANTS

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**INTRODUCTION** Cycling time trial pacing is reproducible in athletes (Thomas et al., 2012). Conversely, less familiar participants exhibit greater inconsistency in pacing (Foster et al., 2009). To reduce variability, it is considered beneficial for more experienced participants to complete at least one familiarisation prior to experimental testing. However, there are no clear guidelines for familiarising novices to a time trial; therefore, findings from novice populations may still be influenced by experience of the task. Consequently, the aim of this study was to investigate the effectiveness of differing familiarisations (length or type) in developing a stable performance and pacing strategy over multiple trials. **METHODS** 30 participants, with no prior experience of a time trial (TT), performed a 20-km cycling TT on five separate occasions, after completing one of three different familiarisations; Full familiarisation (FF, 20-km TT, n=10), Half familiarisation (HF, 10-km TT, n=10) or Equipment familiarisation (EF, 5-min cycling, n=10). Repeated measures ANOVA and coefficients of variations (CV) were used to find differences and variability in performance (total duration and mean power (W/PPO)) and pacing (mean power over 2-km intervals) between trials. **RESULTS** The lowest variation in performance was observed in the FF group after two trials (CV, 1.5-4.3%), compared to the HF (1.8-7.9%) and EF (2.2-5.9%) groups. Pacing in all groups followed a J-shaped pattern with an end spurt. For all groups, the greatest variation in pacing occurred in the first 2-km between TT1 and TT5 (CV, 15.1-17.5%). The HF group showed difference in overall performance from TT1 to TT4 and TT1 to TT5. This was possibly due to an increase in power in the latter stages of subsequent trials, with a lower power output at 14-km observed in TT1 vs TT4 (-11.7%). The EF group displayed the highest variation in end spurt power (CV, 11.6%) between TT4 and TT5. **DISCUSSION** For novel participants in experimental testing, the use of a FF and a further two practice trials is superior in reducing learning effects on performance and pacing. In contrast, HF and EF can have an inhibitory influence on pacing strategy development and consistency, characterised by greater variation in both performance and pacing between trials. This data supports anticipatory regulation theory (Tucker, 2009) and provides recommendations for familiarising novice participants to a 20-km TT. **REFERENCES** Foster C, Hendrickson K J, Peyer K, et al. (2009). *Br J Sports Med*, 43(10), 765-769. Thomas K, Stone M R, Thompson K G, et al. (2012). *Eur J Appl Physiol*, 112(1), 223-229. Tucker R. (2009). *Br J Sports Med*, 43(6), 392-400. **CONTACT** Andrew.hibbert1@live.vu.edu.au

## HIGH-INTENSITY DISTANCE IN ELITE FEMALE SOCCER PLAYERS BASED ON A GENDER-SPECIFIC THRESHOLD

Bellistri, G.1,2, Porcelli, S.2, Marzorati, M.2, Sforza, C.1,2, Giudici, A.2, Bradley, P.S.3

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**Introduction** The total distance covered in elite matches by female soccer players is relatively lower than their male counterparts (Bradley et al. 2014). The majority of female match play is spent in low-intensity activities with high-intensity distance been 30% lower than male players (Andersson et al. 2010). To date, studies on female players utilized the same absolute velocity threshold of male players despite female player having a lower physical capacity than male players (Bradley and Vescovi, 2015). The aim of this study was to examine high-intensity distance covered during matches by elite female soccer players using different thresholds. **Methods** Nineteen elite female players participated in this study (age 23±4 yr; height 165±7 cm; body mass 54.7±6.5 kg). Maximal oxygen consumption (VO<sub>2</sub>max) and respiratory compensation threshold (VT<sub>2</sub>) were determined by graded exercise test to exhaustion on a motorized treadmill. Players activities across 6 friendly matches (32 observations) were tracked by Global Positioning System (K-Gps 10hz, K-Sport, Italy). Distance covered in total (TD) and at high-intensity (HID) were evaluated. The latter was calculated using both the typical male speed threshold of 15 km·h<sup>-1</sup> (MALE) and an individual speed threshold (IND) corresponding to VT<sub>2</sub> (Hunter et al. 2015). **Results** Players VO<sub>2</sub>max was 49.1±3.7 mL·kg<sup>-1</sup>·min<sup>-1</sup> and occurred at a speed value of 14.7±0.8 km·h<sup>-1</sup>. VT<sub>2</sub> corresponded to a running speed of 13.5±0.9 km·h<sup>-1</sup>. The total distance covered was 7726±891 m with HID higher (p<0.0001) in IND (1125±533 m) than in MALE (785±353 m). When expressed as percentages of TD, HID was 14.4±5.8% in IND and 9.9±3.8% in MALE. **Discussions** These data demonstrate in female soccer that the quantification of high-intensity running activities during match play can be impacted by applying relative or absolute speed thresholds. Even if arbitrary speed thresholds enable longitudinal monitoring of match-demands and comparison within and between play-

ers/teams/gender, the utilization of individualized speed threshold should be pursued in order to quantify the correct exercise stimulus in female soccer players. Further studies are needed to understand the best method characterizing the multiple transitions between intensity-domains in female soccer. References Andersson HA, Randers MB, Heiner-Moller A, Krstrup P, Mohr M. (2010). *J Strength Cond Res*. 24, 912-919. Bradley PS and Vescovi JD. (2015). *Int J Sport Phys & Perf*. 10, 112-116. Bradley PS, Dellal A, Mohr M, Castellano J, Wilkie A. (2014). *Hum Mov Sci*. 33, 159-71. Hunter F, Bray J, Towilson C, Smith M, Barrett B, Madden B, Abt G, Lovell R. (2015). *Int J Sport Phys & Perf*. 36, 41-48. Contact giuseppe.bellistri@unimi.it

## ASSOCIATIONS BETWEEN VARIOUS INTENSITIES OF PHYSICAL ACTIVITY AND PHYSICAL FITNESS IN ADOLESCENTS

Kidokoro, T.1, Yanaoka, T.1, Kashiwabara, K.1, Yamagami, J.1, Tanaka, H.2, Miyashita, M.1

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**Introduction** While a positive association between physical activity and physical fitness has been established in adults, the association appears less clear in adolescents (Dencker and Andersen, 2011). The purpose of this study was to examine associations between objectively measured various intensities of physical activity and eight physical fitness tests in Japanese adolescents. **Methods** A total number of 289 Japanese adolescents (age,  $13 \pm 1$  (mean  $\pm$  SD) years; 140 boys and 149 girls) participated in this cross-sectional study. To evaluate the amount of time spent in moderate to vigorous ( $\geq 3$  Mets) physical activity (MVPA), and vigorous ( $\geq 6$  Mets) physical activity (VPA), participants were asked to wear a uniaxial accelerometer (Lifecoder-EX, Suzuken Co. Ltd.) for 14 consecutive days. Physical fitness tests are comprised of eight tests including 1) distance running, 2) 50 m sprinting, 3) grip strength, 4) bent-leg sit-up, 5) side step, 6) sit-and-reach, 7) standing long jump and 8) handball throw. Based on data obtained through accelerometers (i.e., MVPA and VPA), the participants were grouped into quartile categories (Q1 (Least active) ~ Q4 (Most active)). Adjusted logistic regression analyses were performed to examine the odds ratios (ORs) and 95% confidence intervals (95% CI) of being in the lowest physical fitness quartile categories for each variable according to physical activity quartile categories (Q1 ~ Q4). **Results** In both sexes, MVPA was negatively associated with distance running time ( $r < -0.24$ ,  $p < 0.05$ ), and the association was stronger between VPA and distance running time ( $r < -0.33$ ,  $p < 0.001$ ). Adjusted logistic regression (reference category: VPA-Q1) revealed that there was a significant difference in bent-leg sit-up (ORs = 0.18, 95% CI: 0.05-0.69) and handball throw (ORs = 0.20, 95% CI: 0.05-0.81) in VPA-Q4, and distance running (QRs = 0.22, 95% CI: 0.06-0.79) in VPA-Q3 for boys. For girls, there was a significant difference in distance running (QRs = 0.03, 95% CI: 0.01-0.20), 50 m sprinting (QRs = 0.24, 95% CI: 0.07-0.82), bent-leg sit-up (QRs = 0.10, 95% CI: 0.02-0.40), side step (QRs = 0.11, 95% CI: 0.03-0.47) and handball throw (QRs = 0.30, 95% CI: 0.09-0.99) in VPA-Q4 compared to VPA-Q1. **Discussion** These findings may suggest that increasing the amount of time spent physical activity, in particular vigorous physical activity, appears to be an effective strategy for improving physical fitness in this population. Reference Dencker M, Andersen LB. (2011). *J Sports Sci*, 29(9), 887-895.

## THE CONTRIBUTION OF SKELETAL MUSCLE VOLUME AND ARCHITECTURE TO SOCCER-SPECIFIC POWER IN ELITE AND RECREATIONAL YOUTH SOCCER PLAYERS

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**Purpose:** The activity profile in elite soccer match-play is characterised by frequent bursts of explosive activity most often performed in the horizontal direction. The physiological determinants of horizontal explosive performance in elite soccer players have yet to be elucidated. Such information may inform talent identification, physiological assessment protocols and training prescription. This study investigated the potential differences in kinetic and kinematic variables between elite and non-elite soccer players during unilateral horizontal countermovement jump (ULHCMJ) performance and the physiological factors that underpin these differences. **Methods:** A cohort of elite ( $n=23$ ; age,  $18 \pm 1$  yrs; BMI,  $23.1 \pm 1.8$ ) and recreationally trained non-elite ( $n=20$ ; age,  $22 \pm 3$  yrs; BMI,  $23.8 \pm 1.8$ ) soccer players performed three ULHCMJs on a force platform. Ultrasonography was used to measure the volume (Vm) and anatomical cross-sectional area (ACSA) of the quadriceps femoris muscle (QF), and the architecture (fascicle length, Lf; fascicle pennation angle, FPA) of the vastus lateralis muscle (VL). The contributions of these characteristics to horizontal jump performance were assessed using bivariate correlation analyses. **Results:** Elite soccer players elicited greater jump distance (Elite:  $216.0 \pm 14.9$  cm, Non-elite:  $196.1 \pm 15.9$  cm;  $P < 0.001$ ), peak vertical power (Elite:  $1768.2 \pm 389.6$  W, Non-elite:  $1439.2 \pm 278.5$  W,  $P = 0.004$ ) and take-off velocity (Elite:  $216.0 \pm 14.9$  ms<sup>-1</sup>, Non-elite:  $196.1 \pm 15.9$  ms<sup>-1</sup>,  $P = 0.013$ ) compared to non-elite players. They also had greater QF Vm (Elite:  $2853 \pm 508$  cm<sup>3</sup>, Non-elite:  $2429 \pm 232$  cm<sup>3</sup>;  $P = 0.001$ ) and QF ACSA (Elite:  $80.8 \pm 15.8$  cm<sup>2</sup>, Non-elite:  $69.8 \pm 6.7$  cm<sup>2</sup>,  $P = 0.006$ ). There were no differences in VL Lf (Elite:  $12.7 \pm 1.8$  cm, Non-elite:  $12.8 \pm 1.7$  cm;  $P = 0.908$ ) or FPA (Elite:  $14.9 \pm 2.2$  deg, Non-elite:  $14.6 \pm 2.0$  deg;  $P = 0.722$ ). QF Vm and ACSA correlated with CMJ distance (Vm:  $r = 0.366$ ,  $P = 0.016$ ; ACSA:  $r = 0.348$ ,  $P = 0.022$ ) and peak vertical power (Vm:  $r = 0.554$ ,  $P < 0.0003$ ; ACSA:  $r = 0.519$ ,  $P = 0.001$ ). Muscle architecture (neither Lf nor FPA) correlated with any measure of ULHCMJ performance (all,  $P > 0.05$ ). **Conclusion:** Unilateral horizontal explosive capability appears to be an important characteristic of elite youth soccer, and QF Vm and ACSA play significant roles in determining soccer-specific power performance. Practitioners working with talent development programmes should consider the inclusion of regular assessment and development of QF Vm to optimise performance in youth soccer players.

## Oral presentations

### OP-PM76 GSSI Nutrition Award

#### EFFECT OF THE SOURCE OF DIETARY NITRATE SUPPLEMENTATION ON PLASMA NITRITE CONCENTRATIONS AND BLOOD PRESSURE

Jonvik, K.L.1,2, Nyakayiru, J.1, Pinckaers, P.J.M.1, Senden, J.M.G.1, van Loon, L.J.C.1,2, Verdijk, L.B.1

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**BACKGROUND** Dietary nitrate (NO<sub>3</sub><sup>-</sup>) has recently received increased attention due to its potential ergogenic and clinical benefits. The ingestion of dietary nitrate from different inorganic sources (e.g. NaNO<sub>3</sub>, beetroot juice) has been shown to result in elevated plasma nitrate and nitrite levels, thereby increasing the bio-availability of NO. However, it is currently unknown to what extent the actual source of nitrate may affect the subsequent physiological effects upon ingestion. **PURPOSE:** To assess the acute effects of different nitrate-rich food

sources on plasma nitrate and nitrite levels and resting blood pressure in healthy individuals. **METHODS** Using a randomized cross-over design, 11 male and 7 female recreationally active subjects ( $28 \pm 1$  y, BMI  $23 \pm 1$  kg/m<sup>2</sup>) ingested four different beverages, each providing 800 mg ( $\sim 12.9$  mmol) nitrate: sodium nitrate (1.1 g dissolved in water; NaNO<sub>3</sub>), concentrated beetroot juice (116 g; BRJ), a rocket salad beverage (196 g; RS), and a spinach beverage (365 g; SP). Blood pressure was measured at baseline, 2.5 h and 5 h following ingestion. Blood was drawn before, and up to 5 h following ingestion and was analyzed for plasma nitrate and nitrite concentrations. Data were analyzed using repeated measures ANOVA with time and treatment as within-subject factors, with Bonferroni-corrected post hoc testing. Plasma nitrite concentrations represent preliminary data from n=9. **RESULTS** Peak plasma nitrite concentrations were higher in SP ( $794 \pm 148$  nM) compared with NaNO<sub>3</sub> and BRJ ( $541 \pm 80$  and  $515 \pm 76$  nM, respectively;  $P < 0.05$ ), with intermediate values observed for RS ( $645 \pm 114$  nM). Additionally, time to peak nitrite concentration occurred earlier following ingestion of SP ( $120 \pm 26$  min) compared with NaNO<sub>3</sub>, BRJ and RS ( $210 \pm 23$ ,  $203 \pm 25$ ,  $230 \pm 24$  min, respectively;  $P < 0.05$ ). Systolic blood pressure significantly declined 2.5h after ingestion of BRJ and RS ( $-5 \pm 1$  and  $-6 \pm 2$  mmHg, respectively;  $P < 0.05$ ) and 5h after ingestion of SP ( $-7 \pm 2$  mmHg,  $P < 0.05$ ), but did not change with NaNO<sub>3</sub> ( $P = 0.11$ ). Diastolic blood pressure significantly decreased 2.5h after ingestion with all treatments ( $-4 \pm 1$ ,  $-8 \pm 1$ ,  $-7 \pm 1$  and  $-4 \pm 1$  mmHg for NaNO<sub>3</sub>, BRJ, RS and SP, respectively;  $P < 0.05$ ), and remained lower at 5h after ingestion of RS and SP ( $P < 0.05$ ). **CONCLUSION** Ingestion of dietary nitrate from different sources acutely results in substantial increases in plasma nitrite concentrations and a reduction in blood pressure. However, the effects appear to be more pronounced when using vegetable food sources naturally high in nitrate. We conclude that the bio-availability of nitrite is dependent on the nitrate source ingested, thereby affecting subsequent physiological effects. Supported by a grant from the Dutch Technology Foundation STW

### INGESTION OF GLUCOSE OR SUCROSE DURING PROLONGED ENDURANCE TYPE EXERCISE PREVENTS A DECLINE IN LIVER BUT NOT MUSCLE GLYCOGEN CONCENTRATION

Gonzalez, J.T.1, Fuchs, C.J.2, Smith, F.E.3, Thelwall, P.E.3, Stevenson, E.J.4, Trenell, M.I.3, van Loon, L.J.C.2

1: University of Bath (UK), 2: Maastricht University Medical Centre+ (The Netherlands), 3: Newcastle University (UK), 4: Northumbria University (UK).

**Introduction** Carbohydrate (CHO) ingestion during prolonged exercise enhances performance, increases CHO oxidation and may spare muscle glycogen stores (Cermak and van Loon, 2013). Few data are available on the impact of CHO ingestion on liver glycogen stores. When trying to maximize CHO availability during exercise, it may be preferred to ingest a combination of different carbohydrate sources eg. glucose (GLU) and fructose. As sucrose (SUC) provides both glucose and fructose, we hypothesize that sucrose ingestion during exercise may allow greater carbohydrate uptake, resulting in greater sparing of liver and/or muscle glycogen stores when compared to the ingestion of glucose only. **Methods** Fourteen cyclists (VO<sub>2</sub>peak:  $58 \pm 1$  mL/kg/min) completed two 3-h bouts of cycling at 50% W<sub>max</sub> while ingesting either GLU or SUC at a rate of 1.7 g/min. Four cyclists (VO<sub>2</sub>peak:  $60 \pm 3$  mL/kg/min) performed a third test in which only water was consumed for reference. We used <sup>13</sup>C magnetic resonance spectroscopy to determine liver and muscle glycogen concentrations before and after exercise. Expired breath was sampled during exercise to estimate whole-body substrate use. All data are means  $\pm$  SEM. Pre- vs post-exercise liver and muscle glycogen concentrations in the water trial were compared by paired t tests. Liver and muscle glycogen concentrations in the GLU and SUC treatments were assessed by two-way (treatment x time), repeated measures ANOVA with treatment (GLU vs SUC) and time (pre- vs post-exercise) as within-subject factors. **Results** Both liver (from  $454 \pm 17$  to  $283 \pm 41$  mmol/L;  $P < 0.05$ ) and muscle (from  $111 \pm 23$  to  $67 \pm 15$  mmol/L;  $P < 0.01$ ) glycogen concentrations declined during exercise when only water was ingested. Following GLU and SUC ingestion, liver glycogen levels did not show a significant decline following exercise (from  $325 \pm 45$  to  $345 \pm 55$  mmol/L and from  $321 \pm 47$  to  $348 \pm 56$  mmol/L, respectively;  $P > 0.05$ ) with no differences between treatments. Muscle glycogen concentrations declined (from  $101 \pm 11$  to  $60 \pm 9$  mmol/L and from  $114 \pm 13$  to  $67 \pm 9$  mmol/L, respectively;  $P < 0.05$ ), with no differences between treatments. Whole-body CHO utilization was greater with SUC ( $2.03 \pm 0.11$  g/min) vs GLU ( $1.66 \pm 0.10$  g/min;  $P < 0.05$ ). **Discussion** Ingestion of glucose or sucrose (1.7 g/min) during prolonged exercise prevents a decline in liver but not muscle glycogen concentrations. Sucrose ingestion during prolonged exercise does not lead to greater sparing of endogenous muscle or liver glycogen stores when compared to glucose ingestion. **References** Cermak NM, van Loon, LJ (2013). *Sports Med*, 43: 1139. Contact jg833@bath.ac.uk

### EFFECT OF CARNOSINE LOADING AND HIGH-INTENSITY INTERVAL TRAINING ON ENDURANCE CYCLING PERFORMANCE

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**EFFECT OF CARNOSINE LOADING AND HIGH-INTENSITY INTERVAL TRAINING ON ENDURANCE CYCLING PERFORMANCE** Chung, W.1, Rouffet, D.1, Derave, W.2, Bishop, D.1 1: Victoria University (Melbourne, Australia); 2: Ghent University (Ghent, Belgium) **Introduction** Carnosine loading via beta-alanine supplementation is well documented to improve short duration, high-intensity exercise performance [1], but has minimal effect on 1-h cycling time trial performance [2]. In addition to its proposed ergogenic effects on performance, beta-alanine supplementation may also have an ergogenic effect on the training sessions leading into competition performances. Such an outcome could be achieved via an increase in training capacity (i.e. athletes can train harder or longer) or an increase in the adaptive response to the same training load. Indeed, we have reported that reducing metabolic acidosis during training can produce greater improvements in performance and mitochondrial adaptations [3, 4]. It is therefore possible that an increase in muscle buffer capacity as a result of beta-alanine supplementation may reduce the muscle pH during training and promote greater adaptations to training. However, to date, this hypothesis has not been tested. Therefore, our aim was to determine if there was an additive effect of carnosine loading, in combination with high-intensity interval training, on 30-km cycling time trial performance. **Methods** Utilizing a double-blind, placebo-controlled, design, 13 active males (n=7 v 6) were matched and split into two groups (W<sub>max</sub>= $271 \pm 43$  v  $259 \pm 54$  W; VO<sub>2</sub>peak= $51.5 \pm 9.1$  v  $51.6 \pm 5.2$  mL/kg/min) that were supplemented with either 6.4 g/day of beta-alanine or a placebo for 3 weeks in combination with continuous training (loading phase). This was followed by 6 weeks of high-intensity interval training (HIT phase). A graded exercise test (GXT), 30-km time trial (TT) and an assessment of maximal coupled mitochondrial respiration (MR) were performed at Week 0, 3 and 9. **Results** Exercise performance and MR from both groups remained similar during the loading phase ( $p > 0.05$ ), but were improved after 6 weeks of HIT (W<sub>max</sub>=5 and 7% higher, 30 km TT=3 and 3% quicker, MR=43 and 40% higher respectively;  $p < 0.05$ ). There were no significant differences between groups for any of these measures. **Discussion** The combination of carnosine loading and HIT demonstrated no additive effect of beta-alanine supplementation on either exercise performance or improvements in mitochondrial respiration. This can possibly be attributed to the potent physiological adaptations to HIT which may have overshadowed any ergogenic effect upon the response to training. The ergogenic benefit of beta-alanine supplementation for exercise performance appear limited to short-duration, high-intensity

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### DELAYED INSULIN ACTION DURING OGTT IN HABITUAL LOW-CARBOHYDRATE HIGH-FAT CYCLISTS

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Introduction Low-Carbohydrate High-Fat (LCHF) diets have recently received attention for their potentially positive influence on prolonged endurance performance and athlete well-being (Noakes et al., 2014). Literature is scarce on the macronutrient composition and metabolism of competitive athletes habitually consuming a LCHF diet compared to matched athletes on a diet higher in carbohydrate content. This study sought to compare the dietary intake and insulin sensitivity of trained cyclists having habitually consumed (> 6 months) either a LCHF or mixed 'control' (CON) diet. Methods Fourteen (7 LCHF, 7 CON) endurance-trained male cyclists (VO<sub>2</sub>max 61 ± 5 ml·kg<sup>-1</sup>·min<sup>-1</sup> LCHF; 63 ± 8 ml·kg<sup>-1</sup>·min<sup>-1</sup> CON), matched for age (36 ± 6 LCHF; 32 ± 5 CON), body composition (BMI 23.6 ± 1.8 LCHF; 23.4 ± 2.0 CON) and relative peak power output (4.8 ± 0.4 W·kg<sup>-1</sup> LCHF; 5.0 ± 0.4 W·kg<sup>-1</sup> CON), were recruited. Participants completed a 3-day dietary record - analysed by the Automated Self-Administered 24-hour Recall (ASA24) analysis software. After an overnight fast, a resting blood sample was taken, followed by a 2-hour 75g oral glucose tolerance test (OGTT). Insulin-sensitivity was assessed by the Homeostatic Model Assessment (HOMA-IR) and the Matsuda Index. Results Dietary intake was similar between groups except fat and carbohydrate consumption (Protein/Fat/Carbohydrate: 21%, 1.9 g·kg<sup>-1</sup>·d<sup>-1</sup> / 72% / 7% LCHF; 16%, 1.8 g·kg<sup>-1</sup>·d<sup>-1</sup> / 33% / 51% CON). HOMA-IR scores were not significantly different between groups (1.04 ± 0.52 LCHF; 0.89 ± 0.40 CON, p=0.80). LCHF tended to have a lower Matsuda Index compared to CON (1.53 ± 0.64 LCHF; 2.29 ± 0.85 CON, p = 0.07). At all OGTT time points after baseline, plasma glucose was significantly higher in the LCHF group (p<0.01). The insulin profile was significantly different between groups: CON insulin peaked at 30 min and returned to baseline by 60 min; LCHF insulin peaked at 60 min and returned to baseline at 120 min (p=0.03). Discussion LCHF cyclists obtained the majority of their energy (>70%) from fat - in line with prescribed high-fat athletic diets. LCHF cyclists did not present with insulin-resistance (Gayoso-Diz et al., 2013) nor impaired glucose tolerance (Nathan et al., 2007). However, delayed glucose disposal in response to elevated insulin suggests reduced metabolic flexibility: specifically a reduced capacity to metabolise ingested carbohydrate. This is likely due to adaptation to fat as a preferred fuel source and concomitant down-regulation of enzymes involved in carbohydrate oxidation (Phinney et al., 1983). References Nathan D, Davidson M, DeFronzo R, Heine R, Henry R, Pratley R, Zinman B. (2007). *Diabetes Care*, 30 (3), 753-759. Noakes T, Volek J, Phinney S. (2014). *Br J Sports Med*, 48 (14), 1071-1072. Phinney S, Bistrian B, Evans W, Gervino E, Blackburn G. (1983). *Metabolism*, 32 (8), 769-776. Gayoso-Diz P, Otero-González A, Rodríguez-Alvarez M, Gude F, García F, De Francisco A and Quintela A. (2013). *BMC Endocr Disord*, 13, 47-56. Contact G1010217@gmail.com

### EFFECTS OF BLOOD DONATION AND NITRATE INGESTION ON THE PHYSIOLOGICAL RESPONSE TO MODERATE-INTENSITY AND INCREMENTAL EXERCISE

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Introduction Nitrate-rich beetroot juice (BR) can reduce the oxygen (O<sub>2</sub>) cost of moderate-intensity exercise and enhance tolerance to severe-intensity exercise (Bailey et al., 2009). A derivative of nitrate (NO<sub>3</sub><sup>-</sup>), nitric oxide, plays a significant role in the regulation of skeletal muscle blood flow, contraction and efficiency. A reduction in blood O<sub>2</sub> carrying capacity, as a result of blood donation, reduces the tolerance to severe-intensity exercise (Burnley et al., 2006). The aim of this study was to determine whether BR supplementation alters the haemodynamic response, efficiency and tolerance to cycling exercise post blood donation. Methods In a randomised and double blind experimental design, 22 recreationally active volunteers performed moderate-intensity and ramp incremental cycle exercise tests prior to and post withdrawal of ~450 mL of whole blood. Before donation, all subjects (n=22) consumed 7 x 70 mL of NO<sub>3</sub><sup>-</sup>-depleted beetroot juice shots (~0.04 mmol NO<sub>3</sub><sup>-</sup> per 70mL) as a placebo (PL) in the 48 h preceding the exercise tests. Immediately after blood donation and during the 48 h prior to exercise, subjects consumed 7 shots of either BR (~6.2 mmol NO<sub>3</sub><sup>-</sup> per 70 mL; n=11) or PL (n=11). Blood pressure (BP), plasma NO<sub>3</sub><sup>-</sup> and nitrite (NO<sub>2</sub><sup>-</sup>) concentrations, haemoglobin concentration ([Hb]), haematocrit (Hct) and pulmonary V<sub>O</sub><sub>2</sub> responses to exercise were measured during each visit to the laboratory. Results BR supplementation resulted in an increased plasma [NO<sub>3</sub><sup>-</sup>] (PL: 50±14 vs. BR: 845±350 μM; P<0.05) and [NO<sub>2</sub><sup>-</sup>] (PL: 72±21 vs. BR: 619±363 nM; P<0.05) post blood donation. Systolic BP was reduced in BR post blood donation when compared with baseline. [Hb] and Hct decreased significantly from pre to post blood withdrawal, however, no difference was noted between PL and BR. Compared with pre donation, the steady state V<sub>O</sub><sub>2</sub> during moderate-intensity exercise was ~4% lower post donation in BR only (P<0.05). The ramp test peak power decreased from pre donation (PL: 341±70 vs. BR: 331±68 W) to post donation (PL: 324±69 vs. BR: 322±66 W) in both groups (P<0.05). However, the decrement in performance was less in BR compared with PL (P<0.05). Discussion Nitrate supplementation reduces the O<sub>2</sub> cost of moderate-intensity exercise and lessens the decline in ramp incremental performance after blood donation. The results from this study may have implications for improving functional capacity in conditions where normal blood O<sub>2</sub> carrying capacity is impaired. References Bailey SJ, Winyard P, Vanhatalo A, Blackwell JR, DiMenna FJ, Wilkerson DP, Tarr J, Benjamin N, Jones AM. (2009). *J Appl Physiol*, 107, 1144-1155 Burnley M, Roberts CL, Thatcher R, Doust JH, Jones AM. (2006). *Exp Physiol*, 91, 499-509 Contact stj201@exeter.ac.uk

## Oral presentations

### OP-PM77 Aspetar Excellence in Football Award

#### LOW VOLUME SPEED-ENDURANCE TRAINING IMPROVES INTERMITTENT EXERCISE CAPACITY IN HIGHLY TRAINED FOOTBALL PLAYERS IN SEASON: ROLE OF SKELETAL MUSCLE ADAPTATIONS.

Gunnarsson, T., Fiorenza, M., Nyberg, M., Piil, P., Lund, A.P., Rømer, T., Bangsbo, J.

*University of Copenhagen*

**Introduction.** The present study examined, whether 9 weeks of speed-endurance training (SET) in season would improve the intermittent exercise capacity and running economy in highly trained football players and, to what extent this improvement was associated with training-induced muscular adaptations in regards to muscle ion transport capacity and glycolytic metabolism in type I and II fibers. **Methods.** Thirteen highly trained football players completed (means $\pm$ SD) 9.4 $\pm$ 1.7 training sessions of SET during the last 9 weeks of the season corresponding to an adherence of 72.2 $\pm$ 13.1 % of total number of planned SET sessions. SET consisted of 2-3 sets of 6-10 x 5 s all-out sprinting interspersed by 10 s of recovery with 2 min of recovery between sets. SET was always performed at the end of training sessions and the average number of sprints per training session was 20 $\pm$ 3. A resting muscle biopsy was obtained from m. vastus lateralis before and after the 9-week intervention period. In addition, running economy was measured before and after the intervention period on a motorized treadmill during two successive running bouts for 6 and 4 minutes at 10 and 16 km-h<sup>-1</sup>, respectively. **Results.** As a result of the intervention period, the Yo-Yo Intermittent Recovery Test level 1 (YYIR1) performance improved ( $p < 0.05$ ) from 2803 $\pm$ 330 to 3127 $\pm$ 383 m. Running economy at 10 km-h<sup>-1</sup> was ~2.0 % better ( $p < 0.05$ ) after than before the intervention period with no change at 16 km-h<sup>-1</sup>. Protein expression of phosphofructokinase (PFK) and ryanodine receptors (RyR) was unchanged following the intervention period. **Discussion.** The present study demonstrated that a low weekly volume of SET, towards the end of the season, can improve the intermittent exercise capacity in highly trained football players. This part of the season has previously been associated with a decrement in YYIR1 performance (1). The ~2 % improved running economy at 10 km-h<sup>-1</sup>, but not expression of PFK and RyR, may in part explain the improved YYIR1 performance following the implementation of low volume SET in highly trained football players in season. However, other factors may be responsible for a large part of the observed performance improvement. Therefore, we will further investigate the potential role of muscle ion transport capacity, with emphasis on K<sup>+</sup> handling, as an explanatory model for the improved YYIR1 performance, investigating adaptations in single fibres. **Reference List 1.** Mohr, M. and P. Krstrup. Yo-Yo intermittent recovery test performances within an entire football league during a full season. *J. Sports Sci.* 32:315-327, 2014.

#### REPEATED-SPRINT TRAINING IMPROVES O<sub>2</sub> UPTAKE KINETICS AND PERFORMANCE IN HIGHLY TRAINED FOOTBALL PLAYERS: ROLE OF FIBER TYPE SPECIFIC ADAPTATIONS IN SKELETAL MUSCLE

Nyberg, M., Fiorenza, M., Gunnarsson, T.P., Lund, A., Rømer, T., Piil, P., Bangsbo, J.

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**Introduction.** The present study examined whether additional repeated sprint training (RST) would improve intermittent high-intensity performance in highly trained football players during the season and to what extent this improvement was associated with training-induced elevations in oxidative metabolism in type I and II fibers. **Methods.** Thirteen highly trained (semi-professional) football players completed two weekly sessions of RST during the last nine weeks of the season. RST consisted of 2-3 sets of 5 s of sprinting interspersed by 10 s of recovery (repeated 6-10 times per set). To assess V $\dot{O}_2$  kinetics when predominantly type I fibers are recruited, subjects completed three identical running tests before and after the training intervention, each consisting of standing followed by a step increment to moderate-intensity (10 km h<sup>-1</sup>) work rate. Furthermore, to assess V $\dot{O}_2$  kinetics when a greater recruitment of type II fibers would be expected, a step increment from moderate- to high- intensity (16 km h<sup>-1</sup>) work rate was also performed. In addition, a skeletal muscle biopsy was obtained at rest before and after the intervention period. **Results.** After the training intervention, the Yo-Yo Intermittent Recovery Test level 1 performance improved ( $P < 0.05$ ) by 11.6 $\pm$ 6.4% (pre, 2803 $\pm$ 330 m; post, 3127 $\pm$ 383 m;  $\pm$ SD). After training, phase II pulmonary V $\dot{O}_2$  kinetics were 11.4 $\pm$ 16.5% faster (pre, 19.2 $\pm$ 3.9 s; post, 16.7 $\pm$ 3.1 s;  $P < 0.05$ ) in the step transition from standing to moderate-intensity work rate. There was no change in phase II pulmonary V $\dot{O}_2$  kinetics in the high-intensity domain. To investigate local skeletal muscle adaptations, analysis of fiber type distribution and protein content of oxidative enzymes in type I and II fibers will be conducted. **Conclusion.** These findings demonstrate that the ability to perform repeated high-intensity work can be improved in highly trained football players during the last part of the season normally associated with performance decrements by implementing RST. This effect of RST appears to be, at least in part, related to enhanced oxidative metabolism in type I fibers.

#### NATURAL ALTITUDE TRAINING AT 1380 M COMBINED WITH 9 H PER DAY AT 3000 M IS AN EFFECTIVE ALTITUDE TRAINING MODE

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**Introduction** Classically, athletes perform altitude training by living and training at moderate altitude (2000-3000m) for several weeks (Bonetti and Hopkins, 2009). An alternative is to use a live high: train low (LHTL) protocol, inducing hypoxia either naturally or using altitude tents or chambers (Wilber, 2007). The aim of this study was to examine effects of a classical altitude training camp and a modified LHTL protocol (combining natural and simulated modalities) on haemoglobin mass (Hbmass), maximum oxygen consumption (VO<sub>2</sub>max) and time to exhaustion (TTE). **Methods** Eighteen elite-level race-walkers performed 21 days of either classical altitude training (CLASSIC; continuous exposure to 1380 m; n = 10) or LHTL combined with classical altitude training (LHTL+C; 1380 m plus 9 h.day<sup>-1</sup> (overnight) at 3000 m simulated altitude; n = 8). A control group of elite race-walkers (CON; n = 11) lived and trained at 600 m altitude. Hbmass and performance testing was performed before and after the 3-wk intervention. Pair-wise comparisons were made between the two experimental groups, and where possible between the experimental and control data, in relation to the likelihood of the magnitude of the effect exceeding the smallest worthwhile change (SWC) for each variable. The SWC was set at 1.4% for Hbmass, 2.0% for VO<sub>2</sub>max and 3.0% for TTE. Statistical significance for each variable was also tested at  $p < 0.05$ , using paired t-tests. **Results** There was a 3.7% increase in

Hbmass in LHTL+C compared with CON ( $p = 0.03$ ).  $VO_{2max}$  increased by ~3% within both CLASSIC and LHTL+C but was not statistically greater than the 1% increase in CON. There was a ~9% increase in TTE after LHTL+C and a ~8% increase after CLASSIC; both increases were likely greater than the smallest worthwhile change of 3.0%. Discussion These findings indicate that, for elite athletes undertaking altitude training, our combined classic and LHTL method is an effective alternative to conventional camps at moderate altitude. This is especially relevant in countries in which the topography is less than 2000 m. We recommend that low altitude (1380 m) combined with sleeping in altitude tents (3000 m) is a time efficient method to improve Hbmass and  $VO_{2max}$ , with the advantage of less compromised training intensity compared with traditional altitude methods typically conducted at higher altitudes of 2000-3000m. References Bonetti DL, Hopkins WG. *Sports Med.* 2009;39(2):107-27. Wilber RL. *Med Sci Sports Exerc.* Sep 2007;39(9):1610-24. Contact Amelia.carr@gmail.com

### MENTAL FATIGUE IMPAIRS SOCCER-SPECIFIC SKILL PERFORMANCE

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**Introduction** Recent research has shown that mental fatigue impairs intermittent running performance in a task with similar demands to a soccer match (Smith et al. 2015). Further research has reported reductions in perceptual and motor skills of mentally fatigued athletes (Duncan et al. 2015). However, it is unknown whether these results from laboratory-based investigations directly translate into impairments in soccer-specific performance. Therefore, this study investigated the effects of mental fatigue on soccer-specific skill performance. **Methods** In this double-blind, randomized, counterbalanced cross over investigation, we tested soccer-specific skill performance in 14 male soccer players (age:  $19.6 \pm 3.5$  y; experience:  $13.6 \pm 3.2$  y). Players performed the Loughborough Soccer Passing (LSPT) and Shooting Tests (LSST) on two occasions, separated by a minimum of 48 h. The LSPT and LSST were preceded, in a randomised order, by 30 min of mentally fatiguing reading (Stroop task) or emotionally-neutral reading (magazines; control). Subjective mental fatigue was recorded on visual analogue scales before and after reading. Subjective reports of mental effort (for the reading task) and motivation (for the skills tests) were also recorded after reading. LSPT performance was assessed using original time, penalty time, and performance time (original time + penalty time). LSST performance was assessed using shot accuracy, shot speed, and shot sequence time. **Results** Reports of mental fatigue and effort were higher following the Stroop task than the magazines (both  $P < 0.001$ ), while motivation was similar between conditions. LSPT original time was not different between conditions but penalty time was significantly higher in the mental fatigue condition ( $4.9 \pm 7.6$  s vs.  $0.0 \pm 6.2$  s;  $P = 0.005$ ,  $d = 0.71$ ), resulting in a slower performance time ( $52.6 \pm 6.6$  s vs.  $47.9 \pm 7.7$  s;  $P = 0.014$ ,  $d = 0.66$ ). Players performed less accurate ( $1.3 \pm 0.6$  points vs.  $2.0 \pm 0.5$  points;  $P = 0.006$ ,  $d = 1.20$ ) and slower ( $81.8 \pm 4.7$  km/h vs.  $85.0 \pm 5.6$  km/h;  $P = 0.024$ ,  $d = 0.63$ ) shots when mentally fatigued. Average shot sequence time was not significantly different between conditions ( $P = 0.08$ ). **Discussion** Mental fatigue impaired soccer-specific skill performance. Indeed, players made more passing and ball control errors, and performed slower, less accurate shots on goal when mentally fatigued. Combined with recent findings that mental fatigue impairs intermittent running performance (Smith et al. 2015), this novel finding has several important implications for soccer players and coaches. References Duncan M, Fowler N, George O, Joyce S, Hankey J. (2015). *Res Sports Med*, 23(1), 1-13. Smith M, Marcora S, Coutts A. (2015). *Med Sci Sports Exerc.* DOI: 10.1249/MSS.0000000000000592. Contact Mitchell.Smith@uts.edu.au

## Oral presentations

### OP-BN13 Coaching: Team sport I

#### TACKLE TECHNIQUE AND RISK OF INJURY IN HIGH-LEVEL UNDER-18 SOUTH AFRICAN RUGBY UNION PLAYERS

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**Introduction** The incidence of injury in rugby union is high in comparison to other team sports (Brown et al., 2012). Tackle technique has been identified as a major injury risk factor (McIntosh et al., 2010). Previous research has reported on tackle characteristics associated with injury but not specifically on technical tackle criteria (McIntosh et al., 2010; Fuller et al., 2010). Therefore, the aim of this study was to assess tackle technique proficiency in youth rugby union players. **Methods** Injury surveillance was conducted at the 2011-2013 under-18 Craven Week rugby tournaments. Video footage of 49 tackle injury events (23 ball-carries, 26 tackles) and 249 non-injury events (126 ball-carries, 123 tackles) were identified. Each ball-carry/tackle was analysed using standardised technical proficiency criteria. Overall and individual criteria score means and standard deviations were calculated for front-on and side-on/behind tackles for ball-carriers and tacklers. T-tests and effect sizes were calculated to compare injury and non-injury events. The level of significance was set at  $p < 0.05$ . **Results** Overall, front-on and side/behind score for ball-carrier proficiency was significantly lower for injury versus non-injury tackles (effect size=0.85, large;  $p < 0.05$ , and effect size=1.86, large;  $p < 0.0001$ , respectively). Fending away from contact was significantly associated with non-injury outcome for ball-carriers (effect size=1.14, large;  $p < 0.05$ ). For tacklers, overall front-on and side/behind proficiency score was significantly lower for injury and non-injury tackles (effect size=1.03, large;  $p < 0.05$ , and effect size=1.59, large;  $p < 0.0001$ , respectively). Pulling the ball-carrier to the ground was significantly associated with non-injury outcome for tacklers (effect size=1.33, large;  $p < 0.0001$ ). **Discussion** Certain individual technical criteria were associated with a non-injury outcome. For example ball-carriers fending away from contact and tacklers pulling the ball-carrier to ground. This highlights that the failure to execute certain techniques may increase the risk of injury. This study provides applicable information for stakeholders in rugby union and these technical criteria should be emphasized from an early age during tackle technique training (Hendricks et al., 2012). References • Brown JC, Verhagen E, Viljoen W, et al. The incidence and severity of injuries at the 2011 South African Rugby Union (SARU) Youth Week tournaments. *S Afr J Sports Med* 2012;24:49-54. • Fuller CW, Ashton T, Brooks JHM, et al. Injury risks associated with tackling in rugby union. *Br J Sports Med* 2010;44:159-67. • Hendricks S, Jordaan E, Lambert MI. Attitude and behaviour of junior rugby union players towards tackling during training and match play. *Saf Sci* 2012;50:266-84. • McIntosh AS, Savage TN, McCrory P, et al. Tackle characteristics and injury in a cross section of rugby union football. *Med Sci Sports Exerc* 2010;42:977-84.

## TRAINING PROCESS OPTIMIZATION BASED ON GAME SUCCESS PREDICTION IN ENGLISH PROFESSIONAL RUGBY UNION

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**Introduction** Efficient management of athlete preparation can only be realized through a comprehensive analysis of all components of the training process; including daily physiological feedback. The purpose of this study was to determine the most important training and non-training related contributors to game success and the optimization of the training process to achieve the best results. **Methods** The study examined 14 players of a professional rugby team during the 2013-14 season. The data contained anthropometrical, physiological, performance, training load and self-reported wellbeing variables. Physiological readiness of the Central Nervous System, Cardiac System (CS) and Autonomic Nervous System (ANS) were frequently monitored by Omegawave Team+ (Finland). A new analytical logic with Primary, Internal and External contributors' identification was developed. Supervised Learning - Augmented Naive Bayes (ANB) - was used to predict targets. Irrelevant parameters were excluded based on their deterministic relationship with other variables. Predictive accuracy of the models was confirmed with the area under the Receiver Operating Characteristic curve (ROC index) and with a Confusion Matrix of cross-validation  $K=3$ . Normalized Mutual Information (NMI) was used to determine the relative influence of variables on the target. **Results** The initial ANB model for game success included 59 parameters. Predictive accuracy was excellent; average ROC index was 93% computed by cross-validation. Eleven significant predictors were found ( $p < 0.1$ ). Three Primary direct predictors were: Hours Travelled (NMI=11.5%); Resistance Training Load - Sets x Reps (NMI=7.8%); Training Orientation (NMI=7.2%). Internal (physiological) contributors that could improve the Primary contributors (i.e.: Hours Travelled) were identified. An ANB model for Hours Travelled with 26 physiological parameters was created (ROC=84%). Two of the most important contributors involved the CS and ANS: Low Frequency ( $p < 0.05$ ) and High Frequency in Normalized Units ( $p < 0.1$ ). Certain External contributors (i.e. Nutrition and Training Load) were found to be the most significant for optimizing Internal contributors (i.e. CS and ANS), thereby improving a player's trainability. Using predictive biological modeling, an optimal roadmap to successful performance was developed. **Discussion** The analytical modeling enabled effective utilization of recent innovations in big data and data mining in sports science. This process can be implemented by constantly re-evaluating the predictive models by using newly generated external and internal data. Contact roman.fomin@omegawave.com

## LOADS VOLUME AND INTENSITY IN FEMALE HIGH-PERFORMANCE HANDBALL MATCH-PLAY

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**Introduction** Indices of intensity and volume are the very important factors for implementation right training programme in order to prevent overtraining and optimize sport performance. There are different methods for identity training loads volume and intensity in sports (Scott et al., 2013). Assessment of internal loads during handball match-play is a great problem because of prevailed intermittent loads character (Wagner et al., 2014). The aim of this study was to assess load volume and intensity during handball match-play in female high-performance handball field players. **Methods** Match-play volume (total heart beats per match including warm up, break between halves, and cooling down) and intensity was quantified by monitoring heart rate (HR) using Polar Team System (Finland) during 16 matches of semi-professional female handball players ( $n = 14$ ; age  $21.4 \pm 2.7$ ;  $VO_{2max}$  ( $46 \pm 5.8$  ml.kg<sup>-1</sup>.min<sup>-1</sup>) and was expressed in relation to the individual maximal HR (%HRmax), % $VO_{2max}$  obtained through an incremental laboratory test. **Results** HR of the players during playing was  $172 \pm 7.2$  beats.min<sup>-1</sup>, but  $149 \pm 9.1$  beats.min<sup>-1</sup> of the total load (including warming-up, break between halves, and cooling-down). The same alteration was found in %HRmax =  $86.5 \pm 4.5\%$  ( $78.4 \pm 3.7\%$  respectively), corresponding to value of  $VO_{2max}$   $79.4 \pm 6.4\%$  ( $71.5 \pm 5.7\%$ ). Total heart beats per match was  $11125 \pm 270$ , but  $13134 \pm 472$  (including warming-up, break between halves, and cooling-down). **Discussion** Research findings are in line to others researchers studies (Michalsik et al., 2011), there were found a relative workload of 65–80% of %HRmax, a mean of HR 160–170 beats.min<sup>-1</sup>. Wagner with co-authors (2014) suggest that  $VO_{2max}$  during competition players need 55–60 ml.kg<sup>-1</sup>.min<sup>-1</sup>. Nevertheless, that  $VO_{2max}$  of subjects were nearly 10 ml.kg<sup>-1</sup>.min<sup>-1</sup> less compared to elite handball players, values expressed in percentage were at the same level as elite handball. We conclude, that physiological demands during handball match-play is in the same requirements, when mastership of competitive teams is homogeneous. We did not find any publication related to total heart beats per handball match. Such kind of indices would be useful in order to design right training programme in order to simulate training loads similar to competition needs. **References** Michalsik LB, Aagaard P, Madsen K. (2014). J Sports Sci Physical Fitness, (In press). Scott BR, Lockie RG, Knight TJ, Clark AC, Xanne AK, Jonge J. (2013). Int J Sports Physiol Perform, 8, 195–202. Wagner H, Finkenzeller T, Wurth S., Duvillard SP. (2014). J Sports Sci Med, 13, 808–816.

## LOAD AND RECOVERY DURING AN IN-SEASON INTENSIVE GAME PHASE; PERCEPTIONS OF PLAYERS AND COACH.

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**Purpose:** A good relationship between training load and recovery is crucial to maximize performance and prevent overtraining. This balance is especially delicate during intensified phases of training and competition. Research shows that players can perceive the training load heavier than intended by the coach (Brink et al 2014). Up to now, it is unknown if coaches are able to observe the perceived exertion of games adequately and to what extent players are able to recover for the next stimulus. Therefore, the purpose of this study is to investigate to what extent coaches can observe the perceived exertion and recovery of players during an intensive competition period. **Methods:** Rate of perceived exertion (RPE) and Total quality of recovery (TQR) of 13 professional basketball players (age  $27 \pm 3$  y, height  $197.2 \pm 13$  cm, weight  $100 \pm 15$  kg, body fat  $10.3 \pm 3.6\%$ ) were compared with observations of the coach. During an in-season phase of 14 games within 6 weeks (2.3 games/week), each player rated their perceived exertion after each game. TQR scores were filled out before the first training session after a game. The coach rated the observed exertion (ROE) and recovery of each player. **Results:** The perceived load of players was lower than rated by the coach ( $15.3 \pm 2.7$  and  $15.8 \pm 2.0$ ;  $p < 0.05$ ). Furthermore, players perceived lower recovery than what was observed by the coach ( $12.7 \pm 2.9$  and  $15.4 \pm 1.6$ ;  $p < 0.05$ ). The correlations between players' and coaches' load ( $r = .46$ ) and recovery ( $r = .23$ ) were mild/moderate to weak. **Conclusion:** Results show that games were experienced less intense by the players than estimated by the coach. On the contrary, players felt less recovered than observed by the coach before the first training after the game. Differences in perception of exertion and recovery by players and coach can lead to inadequate planning of future training sessions.



Accurately monitoring individual game load and the subsequent recovery may better guide the training process and prevent overtraining.

### WHEN MORE DOES NOT MEAN BETTER - THE VALUE OF WORK-LIFE BALANCE WITHIN A PROFESSIONAL FOOTBALL ARENA

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**Introduction** One of the oldest concerns about athletes' personal development has been around difficulties experienced following retirement from elite sporting careers. Current career transition literature has brought a broader lens to athlete careers and their transitions as well as relevant dimensions of personal and professional development. Stambulova et al (2014). Particular focus has been on the notion of dual career development as a pre-requisite to adaptation after retirement. However, realisation of the salience of conceptualising the professional sport arena as a workplace has led to a concern with players' ongoing well-being and considering work-life balance issues alongside the commitment required to perform at the highest level. The study reported here has therefore undertaken a preliminary examination of how AFL players spend their time when away from the football club and how that might facilitate high levels of engagement in their football activities. **Methods** Data concerning how players spent their committed and free time away from their contracted time as a professional footballer was collected as part of a survey into off-field activities and club support in the middle of the 2013 season. Four hundred and thirty players (Mean age=22.93, SD =3.35) participated from 14 of the 18 clubs within the national league. Results Three quarters of the sample (74.8%) reported that they were involved in activities related to dual career development. The average time committed to this was 4.4 hours per week but with a fairly high standard deviation of 2.75 hours. In total the players reported having an average of 26.08 hours per week that they were able to commit to non-football activities during the season. When amount of time was added to other off-field life variables and controls were added for the club ladder position and players athletic social identity and exclusivity, Multiple Hierarchical Regression showed that 17% of the variance of the players' experience of athlete engagement (Lonsdale et al., 2007) was predicted by the quality of their free time (which was in turn predicted by the perceived level of club support) and the amount of time spent in social activities. **Discussion** These findings provide evidence that time spent in social activities and more significantly perceptions of the quality of the players overall time away from the playing field was able to contribute significantly to the level of their engagement in their work as footballers. Within the context of the length of season the notion of finding a work-life balance would seem to be relevant to achieving better work outcomes for your playing staff. **References:** Lonsdale, C, Hodge, K, Jackson, S.A. (2007). *International J Sport Psych*, 38(4), 471-492. Stambulova et al. (2014), K. Searching for an optimal balance: Dual career experiences of Swedish adolescent athletes. *Psychology of Sport and Exercise*. doi: <http://dx.doi.org/10.1016/j.psychsport.2014.08.009>

## Mini-Orals

### MO-BN01 Motor learning & Biomechanics

#### ATTENTION CONTRIBUTES TO LOW FIDELITY IMITATION OF BIOLOGICAL KINEMATICS IN AUTISM SPECTRUM DISORDERS

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**Introduction** Attentional control processes that modulate imitation of biological kinematics have been linked to compromised imitation fidelity in autism spectrum disorders (autism). Using a novel protocol, we manipulated control by directing attention to a non-human agent displaying atypical and typical kinematics in which peak velocity (PV) was achieved at 18% and 44% of the movement duration, respectively. **Objectives** Examine whether imitation of biological kinematics is modulated by attention. **Methods** Fifteen adults with autism (confirmed using ADOS-2) and fifteen controls participated. Participants in a general-attention condition observed a random sequence of atypical and typical models with the intention to "observe and copy the model", whereas during selective-attention participants were instructed to "observe and copy exactly how the dot moves". Perception of biological kinematics was also examined using a judgement task, and general attention was assessed using a multiple-object tracking protocol. **Results** Although groups did not differ when imitating typical kinematics, the control group ( $28 \pm 8\%PV$ ) imitated atypical kinematics more accurately ( $P < 0.01$ ) than the autism group ( $32 \pm 10\%PV$ ). The control group became 11% more accurate ( $P < 0.01$ ) at imitating atypical kinematics during selective-attention compared to general-attention, whereas there was no attentional modulation in the autism group ( $P > 0.05$ ). The autism ( $74 \pm 17\%$  accurate) and control ( $70 \pm 16\%$  accurate) groups were equally successful at judging biological kinematics ( $P = 0.17$ ). The control group ( $96 \pm 3\%$  accurate) was more successful ( $P = 0.01$ ) than the autism group ( $84 \pm 7\%$  accurate) during the multiple-object tracking task. **Conclusion** Although the autism group made accurate perceptual judgements of biological kinematics, their imitation of those kinematics was compromised. Unlike the control group, imitation fidelity did not improve by manipulating attentional control. Post experimental debriefing confirmed the autism group did intend to imitate how the dot moved. In conjunction with the group difference in multiple-object tracking, and the normal ability in perceiving biological kinematics, these findings are the first to demonstrate low fidelity imitation in autism is linked to attentional processes associated with sensorimotor integration and representation of biological kinematics.

#### AGE RELATED DEPENDENCY ON VISUAL INPUT IN ORDER TO MENTALLY SIMULATE POSTURAL TASKS: AN FMRI STUDY

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**Introduction** Aging induces structural and functional changes in the central nervous system leading to greater cortical activity during manual tasks (Calautti et al., 2001) and cortical disinhibition during postural tasks (Papegaaij et al., 2014). This study aims to further explore age-related differences in postural control by means of fMRI in order to detect cortical and subcortical changes. **Methods** For this purpose, subjects were asked to apply motor imagery (MI), action observation (AO) or the combination of both (AO+MI) to mentally simulate two postural tasks: upright stance (static) or compensation of a medio-lateral perturbation (dynamic). Data from 16 elderly and 16 young (7 females; mean  $\pm$  SD =  $72 \pm 4.58$ ; 6 females; mean  $\pm$  SD =  $27 \pm 4.81$ ) were acquired with a 3T MRI scanner and analyzed with

SPM8. A full factorial model was used to analyze differences between elderly and young. Significant differences were recognized at  $p < .05$  FWE corrected at the cluster level. Results When AO+MI is compared with AO of the dynamic task, elderly displayed larger activation in SMA and PMC, whereas young did not reveal higher activation. For the contrast MI versus AO of the dynamic task young presented higher activity in the cerebellum and putamen than elderly. Inversely, when contrasting AO with MI of the dynamic task elderly exhibited greater activity than young in cerebellum and putamen. Discussion There is a common notion of increased cortical activity in elderly compared to young for mental simulation of movements in general (Nedelko et al., 2010) and for postural control in particular (Papegaaij et al., 2014). However, although elderly showed increased activity in the SMA and PMC in the present study, this was only true for the conditions with visual input (AO+MI and AO). In the condition without visual input (MI), there was no facilitation of cortical areas in the elderly and they even demonstrated a decrease in activity in subcortical areas such as the putamen and the cerebellum. Our results indicate that elderly indeed increase activity in cortical centers probably to compensate for age-related deteriorations in postural control. However, this seems to be only true when they are sufficiently guided by visual input indicating a stronger dependency on vision than young; particularly to activate subcortical brain centers. References Calautti C, Serrati C, and Baron JC. (2001). *Stroke*, 32, 139–146. Nedelko V, Hassa T, Hamzei F, Weiller C, Binkofski F, Schoenfeld MA, Tüscher O, and Dettmers C. (2010). *Restor. Neurol. Neurosci.* 28, 737–747. Papegaaij S, Taube W, Hogenhout M, Baudry S, and Hortobagyi T. (2014). *Front. Aging Neurosci.* 6. audrey.mouthon@unifr.ch

## COMPARISON OF MUSCLE SYNERGIES DURING TREADMILL RUNNING BETWEEN DIFFERENT FOOT STRIKE PATTERNS

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Introduction Runners fall into two broad categories based on foot strike patterns: a fore-foot strike (FFS), in which the ball of the foot lands before the heel comes down; and a rear-foot strike (RFS), in which the heel lands first. The differences between FFS and RFS have been only studied in terms of ground reaction forces (Lieberman et al., 2010), knee loading (Kulmala et al., 2013), and running economy (Gruber et al., 2013). The aim of this study was to compare FFS with RFS based on muscle synergies (Hagio et al., 2015). Methods Six healthy male subjects ran on a treadmill at different speeds (5, 7, 9, 12, and 15 km/h). At each speed, subjects were asked to run both in FFS and RFS. Surface electromyogram (EMG) activity was recorded from 12 muscles on both sides of the trunk and lower body. Muscle synergies were extracted from an EMG data matrix using non-negative matrix factorization (Lee and Seung, 1999). Results Both in FFS and RFS, six synergies (Syn1-6) were extracted. The general characteristics of the synergies were similar between FFS and RFS. However, in all subjects, Syn3 and Syn6, which were activated just before touchdown, recruited tibialis anterior (TA) much more in RFS than in FFS. In a subject, Syn1 and Syn4, which were activated around touchdown, recruited triceps surae (TS) slightly more in FFS than in RFS. Moreover, in two subjects, Syn2 and Syn5, which mainly recruited TS and were activated during stance, showed bi-modal activation patterns in FFS while mono-modal in RFS, so that they were also activated around touchdown in FFS. Discussion The difference of TA seems to come from the necessity of the dorsal flexion of ankle joint just before touchdown in RFS. On the other hand, the reason of the differences of TS and activation patterns seems to be because the activity of TS absorbed touchdown impact in FFS. In conclusion, the results suggest that the central nervous system controls running rhythmically activating six muscle synergies, switches from FFS to RFS changing the weighting in specific synergies, and adjusts the absorption of touchdown impact changing the weightings or the activation patterns. References Gruber AH, Umberger BR, Braun B, Hamill J. (2013). *J Appl Physiol*, 115, 194–201 Hagio S, Fukuda M, Kouzaki M. (2015). *Front Hum Neurosci*, 9:48. Kulmala JP, Avela J, Pasanen K, Parkkari J. (2013). *Med Sci Sports Exerc*, 45(12), 2306–2313. Lee DD, Seung HS. (1999). *Nature*, 401, 788–791. Lieberman DE, Venkadesan M, Werbel WA, Daoud AI, D'Andrea S, Davis IS, Mang'Eni RO, Pitsiladis Y. (2010). *Nature*, 463, 531–535. Contact higashi\_kyoto@me.com

## POSTACTIVATION POTENTIATION INDUCED BY REACTIVE JUMPS COUNTERACTS STRETCH-INDUCED MUSCLE TWITCH DECLINES IN THE TRICEPS SURAE MUSCLE

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Introduction Warm-up procedures often include conditioning activities that serve to enhance performance in a subsequent sport-specific movement. Recently, it has been shown that repetitive reactive jumps (hops) induce postactivation potentiation (PAP) in electrically evoked twitches of the triceps surae muscle (Bergmann, 2013). This potentiating effect might be related to a higher stiffness of the muscle-tendon complex, allowing a higher force contribution from the active components of the muscle (Maloney, 2014). In contrast, stretching reduces the muscle-tendon stiffness, and causes a decline in the electrically evoked muscle twitches (Morse, 2008). Until now, there is no study that looked at the combination of those activities with regard to changes at the muscle-tendon level. Therefore, we designed the present study to test the hypothesis that 10 hops before or after stretching the muscle-tendon unit are able to counteract the stretch-induced decrease of the muscle twitches. Methods Twenty subjects completed 10 electrically evoked twitches of the triceps surae muscle subsequent to 4 different conditioning activities and a resting control in a counterbalanced order. The conditioning included either 10 hops, 20s static stretching of the triceps surae muscle, 20s stretching followed by 10 hops and 10 hops followed by 20s stretching. We determined the isometric twitch peak torque for each twitch response of the triceps surae muscle. Results A repeated measure ANOVA revealed a significantly higher twitch torque immediately after the hops (+22%) and a significantly lower twitch torque after stretching (-7%) compared to control. The combinations stretching after hops and hops after stretching both significantly increased the twitch torque compared to control. Interestingly, the stretching followed by hops revealed a significantly higher increase (+17%) compared to the hops followed by the stretching (+9%). Discussion In this study we were able to show that 10 hops are able to counteract stretch-related declines of the muscle twitch force. Furthermore we clearly demonstrated that the overall potentiating effect is dependent on the order of the conditioning activities. Most likely, the observed counteracting effect takes place on the muscular level, since it has been shown that 20s of static stretching affect the muscle but not the tendon properties (Morse, 2008). Thus, the findings of the present study provide further evidence for the effect of the muscle's activation history on its capacity in generating force. From an applied perspective our results have relevance for tailoring warm-up routines that include sport-specific conditioning activities. References Bergmann J, Kramer A, & Gruber M (2013). *PLoS one*, 8(10), e77705. Maloney S, Turner A, & Fletcher I (2014). *Sports Med*, 1–13. Morse C, Degens H, Seynnes O, Maganaris, C, & Jones D (2008). *J of Phys*, 586(1), 97–106. Contact Jakob.Kuemmel@uni-konstanz.de

### KNEE MUSCLE TENDON COMPLEX FORCES RATIO AND BIOMECHANICAL ANALYSIS IN SQUATTING

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**Introduction** Mechanical properties of the Muscle-tendon complex (MTC) are an important element in studying human performance. A primary aim in training and rehabilitation is developing balanced and simultaneous muscle and tendon adaptation. Understanding of the force distribution in different joint angle is crucial for training and rehabilitation process. The MC sensor (Sensmotion PT2 device, TMG-BMC, Slovenia) [1] is a wearable ( $m < 1.5$  g) biosensor that measures muscle and tendon tension/force. In our research, we focus on quadriceps muscles and tendon and the patellar tendon (PT) force ratio by using MC sensor. We measured the vastus medialis (VM) and lateralis (VL), quadriceps (QT) and patellar tendon (PT) forces during squatting. **Methods** Ten international level athletes (five male and five female, age 20-31) were measured during squatting using Smith machine. Tension forces of VM, VL, QT and PT were measured with the MC sensor with 1 kHz sampling rate. Athlete's movements were captured with Qualisys MCS consisting of 8 Oqus 3+ cameras, with resolution of 1.3 million pixels and 0.5 kHz sampling rate. Ten passive markers were placed on the head, neck, shoulder, elbow, hips, thigh, knee, ankle, foot and weights enabling calculation of the knee angle (KA) and torques (KT) [3]. Muscle and tendon tension forces ratio was then calculated. Results Exponential relation between QT and PT force ratio and KA (in the range from  $20^\circ$  to  $80^\circ$ ) was found, which is below 0.5. On the other hand, linear relation between sum of VM and VL force and PT force ratio was found, which is from 0.2 to 1.55. **Discussion** The reason of this low ratio between QT and PT force in different KA is that the angle between torso and femur is getting lower, causing rectus femoris loosening (nevertheless the activity of rectus femoris is high). In lower angles, the ratio between the sum of VM and VL force and PT force is lower due to low influence of very complex force transmission through the knee joint. In the highest angles, the ratio is above 1, meaning the higher muscle force is required and more force is lost in the transmission path [2]. The idea for the future testing is to make some additional testing and measurements and then describe our results with some mathematical equations that are related to knee joint biomechanics. **References** [1] S.Đorđević et al, MC sensor-a novel method for measurement of muscle tension. *Sensors*, vol. 11, no. 10, 2011. [2] R.P.Grelsamer, J. Klein, *The Biomechanics of the Patellofemoral joint*. *Jurnal of Ortopedic and Sports Physical Therapy*, 1998. [3] G.Yamaguchi, *Dynamic Modeling of Musculoskeletal Motion: A Vectorized Approach for Biomechanical Analysis in Three Dimensions*. Springer, 2005.

### A DESCRIPTIVE OBSERVATIONAL STUDY OF STROKE CHARACTERISTICS IN TEAM BOAT SPRINT KAYAKING

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**Introduction** In team boat sprint kayaking, paddlers compete in the K2 (two-seater) and K4 (four-seater) over distances of 200-, 500-, and 1000-m. As an interacting team sport (Widmeyer & Williams, 1991), crew members must coordinate their efforts throughout the entire race to produce a collective outcome. While it is generally accepted that successful performance requires good synchronisation in strokes between the crew, little has been documented about team boat sprint kayaking. The aim of this study was to identify the stroke characteristics for a K2 200-m crew. **Methods** High-speed (120 Hz) video of a K2 200-m crew from a national team was recorded from the sagittal view during an important selection time trial. Video analysis was performed to identify stroke characteristics of each paddler in a K2, including stroke rate and a four-phase stroke breakdown according to McDonnell and colleagues' model (2012) of Entry, Pull, Exit and Aerial sub-phases. In addition, an offset variable, defined as the timing difference between the back paddler compared to the front, was obtained for each of the phase-defining positions (Catch, Immersion, Extraction and Release). Mean and variability of the stroke characteristics were calculated to compare between the two paddlers. Results Within a K2, both paddlers performed at the same stroke rate of 79 double strokes per minute, but varied considerably when analysed through the four-phase breakdown. For example, the back paddler spent about 50% longer in the Pull sub-phase compared to the front paddler (147 ms versus 96 ms). Coefficient of variations for each paddler were also noted to be larger (10 to 16%) when stroke characteristics were analysed using the four-phase breakdown, as compared to the two-phase breakdown (6%). Also, while there was a noticeable timing offset at the Catch (-24 ms) and Immersion (-42 ms) positions, whereby the back paddler reached the positions before the front paddler did, the offset was negligible by the time the Exit occurred. **Discussion** The results show that stroke characteristics in team boat sprint kayaking are more complicated than previously thought; paddlers in a team boat may paddle at the same stroke rate yet have very different stroke profile when analysed in greater detail. Interestingly, while the general belief is that stroke synchronisation at the Catch position is important for successful team boat paddling, our results found an uncanny similarity at when the Exit position was reached by both paddlers. Further investigations are warranted as to whether reaching the Exit position at the same time can distinguish successful team boat sprint kayaking crews. **References** McDonnell LK, Hume PA, Nolte V (2012). *Sports Biom*, 11(4), 507-523. Widmeyer WN, Williams JM (1991). *Small Group Res*, 22(4), 548-570. Contact cherylts@gmail.com

### MECHANICAL AND MORPHOLOGICAL PROPERTIES OF THE HUMAN QUADRICEPS MUSCLE-TENDON UNIT AFTER WHOLE-BODY VIBRATION TRAINING

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**Introduction** Animal studies suggest that regular exposure to whole-body vibration induces an anabolic response in connective tissue (e.g. bones or tendons; Rubin et al., 2001; Sandhu et al., 2011). Changes in material properties of series elastic elements may alter the muscle force-length relationship (Lieber et al., 1992). However, the effects of this type of intervention on human tendon properties and its possible influence on the function of the muscle-tendon unit have never been investigated. Hence, the aim of this study was to investigate the effect of chronic whole body vibration exposure on the patellar tendon mechanical, material and morphological properties, the quadriceps femoris muscle architecture and the knee extension torque-angle relationship. **Methods** Healthy adults were recruited for an eight-week intervention study and randomized into one of three groups: whole-body vibration, active controls and inactive controls. Subjects of the whole-body vibration and the active control group performed isometric squats on a vibration platform with and without vibration, respectively. Using ultrasonography and dynamometry, the following outcome variables were measured before and after the intervention in 46 subjects: tendon stiffness, Young's modulus and cross-sectional area, muscle thickness, pennation angle and fascicular length and torque-angle relation of the knee extensor muscles. Results Vibration training induced an increase in proximal (6.3%;  $P < 0.01$ ) and mean (3.8%;  $P < 0.01$ ) tendon cross-sectional area, without any appreciable change in tendon stiffness and Young's modulus or in muscle architectural parameters. Isometric torque at a knee angle of  $90^\circ$  increased in active control subjects (6.7%,  $P < 0.05$ ) only and the

torque-angle relation remained globally unchanged in all three groups. No significant changes were observed in muscle and tendon parameters of the two control groups. Discussion The present protocol of whole-body vibration training did not appreciably alter knee extension torque production or the musculotendinous parameters underpinning this function. Nonetheless, this study shows for the first time that whole body vibration elicits tendon hypertrophy in humans. References Lieber RL, Brown CG, Trestik CL (1992). Model of muscle-tendon interaction during frog semitendinosus fixed-end contractions. *J Biomechanics*, 25(4), 421-428. Rubin C, Turner AS, Bain S, Mallinckrodt C, McLeod K (2001). Anabolism: Low mechanical signals strengthen long bones. *Nature*, 412(6847), 603-604. Sandhu E, Miles JD, Dahners LE, Keller SBV, Weinhold PS (2011). Whole body vibration increases area and stiffness of the flexor carpi ulnaris tendon in the rat. *J Biomech*, 44(6), 1189-1191. Contact: florian.rieder@sbg.ac.at

### INTERACTION BETWEEN HIP ANGLE, KNEE ANGLE AND KNEE ANGULAR VELOCITY WHEN MEASURING ISOKINETIC KNEE TORQUE

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Introduction Three main mechanical factors influence single joint torque values: joint angle, angular velocity and adjacent joint angle when biarticular muscles are involved. Whilst the individual effects of each factor on joint torque have been thoroughly investigated (Bohannon et al., 1986; Kawakami et al., 2002), research around the question of the combined effect of all three factors is still scarce. Methods Following two practice sessions, knee flexion and extension torques were measured on a Cybex NORM dynamometer in 10 males. Participants performed a number of submaximal trials prior to the execution of 3 maximal repetitions (seated) at velocities of V30, V90, V150 & V210°/s for each muscle group and under three hip angle conditions: 0° (H0), 45° (H45) & 90° (H90). Overall peak torque was measured for all hip and velocity conditions whereas knee angle specific torques at K30°, K45°, K60° & K75° were obtained for all three hip angles but only for V30 and V90 as the higher velocities limited the range of the isokinetic movement. Results Knee extension values showed no effect of hip angle across all tested angular velocities while the effect of knee angle on torque production was not influenced by the tested hip angle, angular velocity or their combined effect. For knee flexors, the H45 and H90 facilitated significantly higher (velocity normalised) peak torque values than the H0 condition (31% and 27% respectively,  $p < 0.01$ ) but there was no interaction between hip angle and velocity. Furthermore, as the knee angle increased peak torque decreased for all hip conditions, however the rate of decrease for the H45 and H90 was lower than H0, with H45 and H90 producing statistically higher values ( $p < 0.01$ ) than H0 for each selected knee angle (K30° = 52% and 63%, K75° = 73% and 100% respectively). When values were expressed as a percent reduction of the K30° values, H90 showed a smaller magnitude of drop than H0 at K75° (34% vs. 47%,  $p < 0.01$ ). Discussion Whilst knee extensor torques are not affected by different hip positions, hip angles of 45° and 90° are superior in producing higher flexor torques across all knee angles and angular velocities with the hip at 90° suggested as the optimal position. The differences between flexion and extension torques in response to changes in hip angle are likely to be caused by different relative contributions of biarticular muscles. Therefore, when a full picture of knee isokinetic functionality is needed, the relation of the three input variables (hip angle, knee angle, angular velocity) with respect to the output knee torque value should be always documented. References Bohannon R, Gajdosik R, LeVeau B. (1986). *Phys Ther*, 66, 1083-1086. Kawakami Y, Kubo K, Kanehisa H, Fukunaga T. (2002). *Eur J Appl Physiol*, 87, 381-387. Contact n.jongerius@leedsbeckett.ac.uk

## Mini-Orals

### MO-PM03 Muscle, Molecular Biology and Biochemistry

#### EXERCISE INDUCES ADAPTIVE GENE EXPRESSION THROUGH NOX2-DEPENDENT REACTIVE OXYGEN SPECIES IN SKELETAL MUSCLE.

Henríquez-Olguín, C., Valladares, D., Díaz-Vegas, A., Utreras-Mendoza, Y., Campos, C., Arias-Calderón, M., Altamirano, F., Jaimovich, E.  
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Reactive oxygen species (ROS) participate as signaling molecules in exercise training adaptation. A physiological ROS production is required to activate redox sensitive pathways that may modulate acute and chronic responses to exercise training. It has been recently reported that exogenous dietary antioxidants can impair early or long-term effects of exercise. However, the ROS source and the molecular mechanisms involved in these phenomena are still not completely understood. The aim of this work was to study the role of NADPH oxidase (NOX2) in response to endurance exercise. BALB/c mice (6-wk-old), pretreated with either apocynin (3 mg/Kg) or saline for 3 days, were swim-exercised for 60 min. Exercise significantly increased NOX2 complex (p47-gp91 interaction) demonstrated by proximity ligation assay in flexor digitorum brevis cryosections (FDB) and by co-immunoprecipitation. In addition, p-p47phox levels were significantly upregulated by exercise in FDB whole lysates. Activation of NOX2 was completely inhibited by apocynin treatment, and it was associated with a reduced activation of p38, ERK 1/2, and NF- $\kappa$ B signaling pathways after exercise training. On the other hand, exercise increased the gene expression of Interleukin-6 (IL-6), manganese superoxide dismutase (MnSOD), glutathione peroxidase (GPx), and mitochondrial transcription factor A (Tfam) in FDB muscles, which was blocked by apocynin treatment. Moreover, the increase in plasma IL-6 elicited by exercise was decreased in apocynin-treated mice compared with the exercised group ( $p < 0.001$ ). This same result was obtained in vitro exercise using gp91-dstat (NOX2 inhibitor), but not with a mitochondrial-targeted antioxidant (EUK 134). In conclusion, the present investigation showed for the first time that NOX2 is activated by exercise inducing the activation of redox sensitive pathways, suggesting a major role of NOX2 in ROS-dependent muscle adaptations. This is a novel mechanism that may explain previous reports related with antioxidant supplementation and exercise effects.

## MYOSIN HEAVY-CHAIN 2X EXPRESSION INTERACTS WITH ACUTE REGULATION OF PGC-1ALPHA SPICE-4 FOLLOWING STRENGTH EXERCISE WITH LOW AND MODERATE VOLUME

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**Introduction** PGC-1alpha splice-4 (-S4) has been implicated as a positive regulator of muscular hypertrophy in response to strength training[1]. The aim here was to explore gene expression of PGC-1 $\alpha$ -S4 in response to an acute strength-exercise session of low (1-set per exercise), and moderate volume (3-sets per exercise), and to explore effects of muscle fiber-type characteristics on gene regulation patterns, using a within-participant model. **Methods** Eight female (mean $\pm$ sd for age, 23  $\pm$  0.6 yrs; weight, 62  $\pm$  4.2 kg; height, 169  $\pm$  3.7 cm) and seven male (23  $\pm$  1.1 yrs, 83  $\pm$  8.1 cm, 180  $\pm$  6.7 cm) recreationally active university students performed one strength training session consisting of three unilateral leg exercises (leg press, leg curl and leg extension), wherein one leg performed a single set per exercise and the contralateral leg performed three sets at an intensity of 10-repetition maximum (balanced for leg dominance). Skeletal muscle biopsies were obtained from m. vastus lateralis prior to exercise, and 1h, 4h and 48h after completion of exercise. To evaluate relative abundances of PGC-1alpha4, RNA was isolated and analyzed by means of qRT-PCR using RPL-32 as the reference gene. MyHC2X expressions were expressed as percentage of overall MyHC-family expression[2]. **Results** There was a main effect of time, PGC-1alpha4 mRNA was increased 1h (1-set, 1.5-fold, CI: 1.2-1.9; 3-sets, 1.8-fold, CI: 1.5-2.1,  $p < 0.05$ ) and 4h following exercise (1-set 2.4-fold, CI: 1.6-3.7; 3-sets, 3-fold, CI: 2.2-4.2,  $p < 0.01$ ), and decreased 48h following exercise (1-set, 0.7, CI: 0.5-1; 3-sets 0.7, CI: 0.5-0.9,  $p < 0.01$ ). There was no general effect of exercise volume. Using baseline MyHC2X expression as an independent variable provided a significantly improved model fit by explaining PGC-1alpha4 regulation at 4h, estimating a 1.1-fold change in PGC-1alpha4 per unit increase in MyHC2X expression ( $p < 0.01$ ). There was no interaction effect between exercise volume and MyHC2X expression on PGC-1alpha4 regulation. Expression of other MyHC-isoforms or sex did not contribute significantly in explaining PGC-1alpha4 regulation. Conclusions PGC-1alpha4 responses did not differ between strength exercise with low and moderate volume. However, training-induced alterations in PGC-1alpha4 interacted with relative MyHC2X expression, highlighting the importance of accounting for muscle fiber characteristics when assessing the adaptive profile to strength training. **References** 1. Ruas et al. (2012) Cell 151(6): 1319-1331. 2. Ellefsen et al. (2014) Scand J Med Sci Sports 24(5): e332-342.

## ASSOCIATION BETWEEN THE IGF2/ACE GENOTYPE COMBINATION AND JUDO STATUS

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**Introduction** Genetic polymorphism is shown to be associated with human physical performance. The angiotensin I converting enzyme (ACE) polymorphism and the  $\alpha$ -actinin-3 (ACTN3) R577X polymorphism have been most widely studied for the analysis of such associations. We have recently found that insulin-like growth factor 2 (IGF2) G/A polymorphism may be associated with judo status. There is a possibility that the combinations of genetic polymorphisms are more effective than alone. Accordingly, the purpose of this study was to evaluate the association between the ACTN3/ACE, ACTN3/IGF2, or ACE/IGF2 genotype combinations and judo status. **Methods** The subjects included 156 male judo players belonging to top-level universities in Japan. They were divided into three groups based on results in national or international competitions. Sixteen athletes were classified as "international level", 37 as "national level", and 103 as "others". DNA was extracted from their saliva and genotyping using PCR-RFLP was conducted to detect ACTN3 (rs1815739), ACE (rs1799752), and IGF2 (rs680) gene polymorphisms. The relative frequencies of these combinations of genetic polymorphisms were compared between the "international-level" and "other" categories using chi-square test. **Results** There was no significant difference in the relative frequencies for the ACTN3/ACE genotype combination (Massidda et al., 2012; Ahmetov et al., 2013). However, those for the ACE/IGF2 genotype combination differed significantly between judo athletes placed into "international-level" and "other" categories (I-GG: 43.8% vs. 26.3%, I-A: 31.3% vs. 55.3%, DD-GG: 18.8% vs. 2.9%, DD-A: 6.3% vs. 15.6%,  $p = 0.01$ ). There was a trend in the relative frequencies of the ACTN3/IGF2 genotype combination in the "international-level" category as compared to those of the same combination in the "other" category (R-GG: 43.8% vs. 19.5%, R-A: 31.3% vs. 43.7%, XX-GG: 18.8% vs. 9.7%, XX-A: 6.3% vs. 27.2%,  $p = 0.06$ ). **Discussion** It has been reported that the best combined genotype for the greatest strength is ACE DD-ACTN3 RR. However, we found an association between the IGF2/ACE but not the ACTN3/ACE genotype combination and judo status. The combination of ACTN3 and ACE is suggested to be associated with performance in closed-skill sports such as swimming or track. The findings of the present study suggest that the combination of IGF2/ACE but not that of ACTN3/ACE may be the candidate combination of genetic polymorphism associated with judo status. **Reference** Massidda M et al. (2012). J Sports Med Phys Fitness, 52(3), 328-334. Ahmetov II et al. (2013). J Physiol Sci, 63(1), 79-85. Contact machidas@juntendo.ac.jp

## ACTOVEGIN, A NON-PROHIBITED DRUG, MAKES HUMAN SKELETAL MUSCLE MORE OXIDATIVE

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**Introduction** The non-prohibited drug Actovegin, a deproteinized hemodialysate of calf blood, is suggested to have ergogenic properties, but this potential effect has never been investigated in human skeletal muscle. Instead, these speculations have emerged because Actovegin has been used as a performance-enhancing drug by Tour de France riders and by Olympic athletes (1). To explore a possible mechanistic explanation for the purported ergogenic effect, we investigated the ex vivo effect of Actovegin on the mitochondrial respiratory capacity in human skeletal muscle. We hypothesized that Actovegin would increase the mitochondrial respiratory capacity in a dose dependent manner. **Methods** Muscle biopsies were obtained from m. vastus lateralis of 8 middle aged, overweight and sedentary subjects. Mitochondrial respiratory capacity was measured by means of high-resolution respirometry (Oxygraph-2k; Oroboros, Innsbruck, Austria) in permeabilised human skeletal muscle fibers acutely exposed to two doses (10 $\mu$ l/ml and 50 $\mu$ l/ml) of Actovegin prior to (for 50min) and during the respiratory measurements (for ~90min). Respiration was stimulated by sequential addition of malate, glutamate, ADP, succinate and FCCP. **Results** In the presence of complex I-linked substrates, Actovegin increased the oxidative phosphorylation (OXPHOS) capacity significantly in a concentration dependent manner (19 $\pm$ 3, 31 $\pm$ 4 and 45 $\pm$ 4pmol/mg/s). Maximal OXPHOS capacity with complex I and II-linked substrates was increased by Actovegin with the high dose (62 $\pm$ 6, 69 $\pm$ 6 and 77 $\pm$ 6pmol/mg/s) ( $P < 0.05$ ). Actovegin also increased ( $P < 0.05$ ) the respiratory capacity of the electron transfer system, the maximal rate of mitochondrial ATP production and the mitochondrial ADP sensitivity in a concentration dependent manner (70 $\pm$ 6, 79 $\pm$ 6 and 88 $\pm$ 7pmol/mg/s; 13 $\pm$ 2, 25 $\pm$ 3 and 37 $\pm$ 4pmol/mg/s; 0.08 $\pm$ 0.02, 0.21 $\pm$ 0.03 and 0.36 $\pm$ 0.03mM, respectively). **Discussion** To our knowledge we report for the first time that

Actovegin has a marked effect on the mitochondrial respiratory capacity in human skeletal muscle. This was in line with our hypothesis and in line with an earlier study in rat hepatic mitochondria reporting an increased mitochondrial respiration after exposures to Solcoseryl; another calf blood extract (2). Whether this improvement translates into an ergogenic effect in trained individuals and thus reiterates the need to include Actovegin on the World Anti-Doping Agency's active list remains to be investigated. [ssoendergaard@sund.ku.dk] 1. Tsitsimpikou C, Tsiokanos A, Tsarouhas K, Schamasch P, Fitch KD, Valasiadis D, Jamurtas A. (2009). *Clin J Sport Med*, 19(1):33-38. 2. Kuninaka T, Senga Y, Senga H, Weiner M. (1991). *J Cell Physiol*, 146(1):148-55

## **TWO BLOCKS OF HIGH FREQUENCY LOW-LOAD BLOOD FLOW RESTRICTED RESISTANCE EXERCISE INCREASED MYONUCLEAR NUMBER IN TYPE I FIBERS IN NATIONAL LEVEL POWERLIFTERS**

Bækken, L., Bjørnsen, T., Kirketeig, A., Wernbom, M., Paulsen, G., Samnøy, L., Berntsen, S.

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**Introduction:** Low-load blood flow restricted resistance exercise (BFRE) is shown to induce muscle hypertrophy, mainly in untrained individuals, but also in some athletic populations (1). Noteworthy, high frequency BFRE has been shown to increase the number of satellite cells and myonuclei in untrained subjects (2). This adaptation might be an important part of the hypertrophic process. So far, BFRE has not been investigated in highly trained competitive strength athletes. Thus the purpose of the present study was to investigate whether two blocks of practical low-load BFRE (pBFRE) during six weeks of periodized strength training could influence the number of satellite cells and myonuclei in powerlifters. **Methods:** Seventeen national level powerlifters (25±6 years (mean±SD); 15 men) volunteered for the study and were randomly assigned to either a pBFRE group (n=9) or a control group (CON; n=8). The 6-week periodized strength program was similar for both groups, except for two blocks (week 1 and 3) where the pBFRE group performed five sessions of low load pBFRE (25-30% of 1 repetition maximum (1RM)) front squats while the CON group performed normal front squats (~70% of 1RM). The pBFRE protocol consisted of four sets to voluntary failure (30 s rest between sets). To restrict the blood flow elastic knee bands were wrapped around the proximal end of the thighs to a pressure of ~120 mmHG (verified with an underlying pressure cuff in the first session). Thickness of the m. vastus lateralis (VL) was measured using ultrasound imaging. Strength was assessed in 1RM front squat. Muscle biopsies were obtained from VL before and after the 6-week intervention and analyzed for satellite cell and myonuclei content. **Results:** The pBFRE showed significant larger increase in thickness for VL compared to the control group (4.7±3.3%, vs. -0.8±5.0%, respectively, p=0.02). Changes in front squat did not differ significantly between groups. Immunohistochemical analyses showed that NCAM/Pax7-positive satellite cells per muscle fiber increased more in the control group than in the pBFRE group (24.7±27.1% vs. -7.9±15%, respectively, p=0.01), whereas the number of myonuclei in type I fibers increased more in pBFRE group than in the control group (17.8±12.8% vs. 0.4±12.9% respectively, p=0.01). **Discussion:** Firstly, the results showed that pBFRE had a hypertrophic effect on m. vastus lateralis, which can have been mediated through the myonuclear addition in type I fibers. Surprisingly, the satellite cell number was not increased with BFRE, but early satellite cell proliferation is nevertheless the most likely cause of the increase in myonuclei in the pBFRE group (3). **Conclusion:** pBFRE during front squat induced hypertrophy in m. vastus lateralis in powerlifters, and the hypertrophic response seemed to be related to type I specific addition of myonuclei. **References:** 1 Yamanaka et al. *J Strength and Cond Res* 26(9): 2523-2529, 2012 2 Nielsen et al. *J Physiol* 590 (17): 4351-4361, 2012 3 Snow. *Anat Rec.* 227(4): 437-46, 1990

## Mini-Orals

### MO-SH01 Social Sciences and Humanities in Sport

#### **DROPOUT IN GERMAN AGE-GROUP SWIMMING**

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**INTRODUCTION** German Swimming has lost connection to the increasing world class level. Reasons are seen in complex deficits of the training processes (Pfützner, 2013). On one hand there is a claim for earlier training start and higher training volume at young age (Güllich, 2013; Lambertz, 2014; Rudolph et al., 2006) on the other hand scientific finding emphasize the successful "side-enteres" in the system (Güllich & Emrich, 2012; Sokolovas, 2006). The longitudinal investigation of careers of German age-group swimmers may reveal evidences for the long term development. Therefore, we investigated drop-out rate in age-group swimming. **METHODS** For the calculation 100 best age-group swimming performances (longcourse) in eight subsequent years (2004-2013) were dissected. The age-groups 1993 - 1995 (m/f) were observed (male n = 1.862; female n = 1.993). For calculating the dropout rate swimmers ranked, in thirteen different events, at the age of 11 where followed until the age of 18. **RESULTS** The mean dropout rate was 68.2 ± 6.5%, independent from the age-group, strokes and sex. Less than one of three swimmers who were ranked in the top-100 in their age-group with 11 years is still in at least one event ranked at the age of 18. About 33% of all swimmers were ranked only one time in the observed years, and only 11.2% were ranked in every single year. **DISCUSSION** We conclude that there are only a few continuous carriers among age-group-swimmers. This is in contrast to the German support system and long term development planning and should be addressed in future research. **REFERENCES** Güllich, A. (2013). *Talente im Sport*. In A. Güllich (Ed.), *Sport* (pp. 624–653). Heidelberg: Springer Verlag. Güllich, A., & Emrich, E. (2012). Individualistic and Collectivistic Approach in Athlete Support Programmes in the German High-Performance Sport System. *European Journal for Sport and Society*, 9(4), 243–268. Lambertz, H. (2014). *Das Perspektiv-Team-Projekt*. Kassel. Pfützner, A. (2013). *Internationale und nationale Tendenzen der Leistungssportentwicklung auf Grundlage der Ergebnisse der Olympischen Spiele in London 2012*. *Leistungssport*, 1. Rudolph, K., Wiedner, H., Jedamsky, A., Spahl, O., & Döttling, W. (2006). *Nachwuchskonzeption im Schwimmen*. Sokolovas, G. (2006). *Analysis of USA Swimming's All-Time Top 100 Times*. In J. P. Vilas-Boas, F. Alves, & A. Marques (Eds.), *Proceedings of the Xth International Symposium on Biomechanics and Medicine in Swimming* (Vol. 6, pp. 315–317). Porto: University of Porto. **CONTACT** i.staub@dshs-koeln.de

## COACH LEADERSHIP AND GENDER IN NORWEGIAN AMATEUR BOXING

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**Introduction** Coach leadership is a substantial factor in developing talent, sport expertise and motivational climate among athletes (Riemer, 2007; Young & Medic, 2008). Worldwide, coaching is a male preserve and female coaches are a rare exception in elite sport. Gender has been shown to affect coach leadership (Pfister, 2013). Therefore, the purpose of this study was to examine styles and forms of coach leadership and how these are influenced by constructs of gender. **Methods** A national sample of 59 boxing coaches (53 male, 6 female) from Norway participated in this study. The methods of investigation were an online quantitative survey using the Leadership Scale for Sports (Chelladurai & Saleh, 1980) and qualitative interviews focusing on leadership and meanings of gender. 8 coaches (5 male, 3 female) were chosen for interviews. **Results** The most frequent self-reported dimensions of leadership behaviour among the coaches were positive feedback ( $M=4.36$ ,  $SD=.41$ ), training and instruction ( $M=3.85$ ,  $SD=.45$ ) and democratic behaviour ( $M=3.32$ ,  $SD=.59$ ). No significant gender differences in coach leadership among Norwegian boxing coaches were found in the survey data ( $p=0.05$ ). The qualitative results indicated that male coaches perceived themselves as more autocratic, while female coaches emphasised a democratic leadership style. Female coaches were seen as exceptional and often associated with traditional female roles such as caretakers. The male dominated culture affected the way good leadership was defined and assessed. A consequence of this was that women's approaches to leadership were not included in the definition of good leadership. **Discussion** Boxing is a male dominated sport. This is likely to affect leadership and meanings of gender among coaches and athletes. My research is limited to how coaches experience leadership and gender. How this affects the coach-athlete relationship, athlete motivation and development would be relevant topics for further research. **References** Chelladurai, P. & Saleh, S.D. (1980). Dimensions of leader behavior in sports: development of a leadership scale. *Journal of Sport Psychology*, 2, 34 – 45. Pfister, G. (2013). Outsiders: Female Coaches Intruding Upon a Male Domain? in G. Pfister & M.K. Sjørd (eds.) *Gender and Sport – Changes and Challenges* (71 – 103). Germany: Waxmann. Riemer, H.A. (2007). Multidimensional Model of Coach Leadership. in S. Jowett & D. Lavallee (eds.) *Social Psychology in Sport* (57 – 75). Champaign, United States: Human Kinetics. Young, B.W. & Medic, N. (2008). The motivation to become an expert athlete: how coaches can promote long-term commitment. In D. Farrow, J. Baker & C. MacMahon (eds.). *Developing sport expertise – Researchers and coaches put theory into practice* (pp.43-60). Oxon: Routledge. Contact [anne.tjonndal@ntnu.no](mailto:anne.tjonndal@ntnu.no)

## INCREASED PHYSICAL ACTIVITY IN SCHOOL IMPROVES SCHOOL RESULTS IN BOYS

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**Introduction** The proportion of Swedish children who finishes the 9th and final year of compulsory school without sufficient grades (defined as enough to be eligible for higher education) has increased during recent decades. As physical activity (PA) has been associated with favorable intellectual performance, increased physical education (PE) in school may contribute to reverse this negative trend. **Methods** We conducted a nine-year prospective population based controlled intervention study where the intervention school increased the level of PE from Swedish standard of 60 minutes per week to 40 minutes daily (200 min per week) during all 9 compulsory school years in 339 children. This cohort finished elementary school 2007 to 2012. Two control groups continued with the Swedish standard of 60 minutes of PE per week during the school years, (i) children attending the intervention school before intervention was initiated, from 2003 to 2006 ( $n=569$ ) and (ii) all Swedish children (except those attending the intervention school) who finished elementary school during the study period of 2003 to 2012 ( $n=1\ 161\ 523$ ). We obtained official final grades and recorded (i) proportion of individuals with sufficient grades to be eligible for higher education and (ii) the sum of the grades of the 16 compulsory school subjects, which could vary from 0 (no subject with accepted grade), to 320, (the highest grade in all subjects). Data are reported as means with standard deviations (SD) and changes from before to after the intervention as means with 95% confidence intervals. No measurement of dispersion is given for the control group (ii), as it is no sample. **Results** The proportion of boys in the intervention school with sufficient grades was 88.6% before intervention and 95.7% with the intervention, a 7.1% (95% CI 1.9, 12.2) increase. The average sum of all grades in boys in the intervention school was  $195 \pm 56$  before intervention and  $211 \pm 45$  with the intervention, a 16.1 point (95% CI 6.5, 25.6) increase. In all Swedish boys (control group ii) the proportion with sufficient grades decreased from 88.2% to 87.4%, a decrease with 0.8%, while the average sum of all grades increased from 195.7 to 198.4, an increase with 2.7 during the same period. In girls, we found similar trends but without statistical significance. **Discussion** Daily school-based PE during all nine compulsory school years improves, in boys, grades and eligibility to higher education. Similar, but non-significant, trends were found in girls. Contact [jesper.fritz@med.lu.se](mailto:jesper.fritz@med.lu.se)

## DEVELOPMENT OF EXCELLENCE IN YOUNG NORWEGIAN ATHLETES - THE IMPORTANCE OF SELF-DETERMINED MOTIVATION AND SELF-REGULATORY COMPETENCIES

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**Introduction** In sport, self-regulatory competencies and a more autonomous form of motivation positively influence development and performance level (e.g., Gillet, Vallerand, & Paty, 2013; Toering, Elferink-Gemser, Jordet, & Visscher, 2009). Hence, this study examine how motivation and self-regulatory competencies combined relate to performance level among youth winter-sport athletes attending different elite sport colleges in Norway. **Methods** 199 winter sport athletes participated in this cross-sectional study (16-20 years ( $M = 18$ ,  $SD = .97$ ), 36.9 % women). The study examines the athletes' different regulations of autonomous motivation, key self-regulatory competencies, and performance level at the beginning of the competitive season. Descriptive analyses, ANOVA, and Structural Equation Modeling were performed. **Results** Preliminary analyses (ANOVA) revealed that international level athletes demonstrated more self-determined motivation (i.e., intrinsic and integrated regulation,  $p < .001$ ) and higher levels of self-regulatory competencies (i.e., planning, reflection, evaluation,  $p < .01$  and consideration of future consequences,  $p < .05$ ) in comparison to national and regional level athletes in Norway. Primary analyses underlined these results during confirmatory factor analysis. The measurements (motivation and self-regulation) demonstrated acceptable fit,  $\chi^2(317) = 477.22$ ,  $p > .05$ ,  $RMSEA = .05$ , 90 % CI [.04, .06],  $CFI = .92$ ,  $TLI = .91$ , and  $SRMR = .07$ . Factor loadings especially underlined the importance of intrinsic regulated motivation and three key self-regulatory competencies; planning, reflection, and evaluation ( $p < .001$ ). **Discussion** The current study revealed that autonomous forms of motivation and self-regulatory competencies combined describe athletes at higher competitive performance levels. These associations have been investigated separately (e.g., Gillet et al., 2013, Toering, Elferink-Gemser, Jordet, & Visscher, 2009), whereas this study underline the importance of emphasizing the

interaction between motivation and self-regulation during youth athlete development. References Gillet, N., Vallerand, R. J., & Paty, B. (2013). Situational motivational profiles and performance with elite performers. *J Appl Sport Psychol*, 43(6), 1200-1210. Toering, T. T., Elferink-Gemser, M. T., Jordet, G., & Visscher, C. (2009). Self-regulation and performance level of elite and non-elite youth soccer players. *J Sports Sci*, 27(14), 1509-1517.

### THE MEDIATION ROLE OF BARRIER EFFICACY WITHIN TASK EFFICACY-PHYSICAL ACTIVITY AND ENJOYMENT-PHYSICAL ACTIVITY RELATIONSHIP

Zhang, S., Lau, W.C.

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**Introduction** The promotion of health behavioral change towards active lifestyle has been one of the public health priorities. Exercise-related Self-efficacy and enjoyment have been recognized as important psychological variables that influence physical activity (PA) behaviors and has been widely adapted in theoretical-based interventions. However, the outcomes of existing interventions are mixing and the role of exercise-related task and barrier efficacy (as subtypes of self-efficacy) and enjoyment in PA behavior is still not fully understood. This study aimed to : 1) explore the mechanism of task efficacy, barrier efficacy, and enjoyment in children's PA behavior; 2) provide practical hints for future theoretical-based interventions. Method 224 schoolchildren aged from 9 to 11 (male=117, female=105) were recruited voluntarily in a local primary school. Self-Efficacy Scale (McAuley & Mihalko, 1998) and Physical Activity Enjoyment Scale (Kendzierski & DeCarlo, 1991) were adapted to measure task efficacy, barrier efficacy, and enjoyment. ActiLife accelerometer was applied to measure PA level. All participants wore the accelerometer for a full calendar week. Wear time validation was done and Evenson et al.'s (2008) cut points for moderate-to-vigorous physical activity (MVPA) was used to analyze accelerometer data. Results Mediation analysis using bootstrap method revealed that barrier efficacy fully mediated the positive relationship between task efficacy and daily total PA (Adjusted  $R^2 = .52$ ,  $F=120.09$ ,  $p<0.01$ ), task efficacy and daily MVPA (Adjusted  $R^2 = .55$ ,  $F=136.97$ ,  $p<0.01$ ), enjoyment and daily total PA (Adjusted  $R^2 = .51$ ,  $F=119.53$ ,  $p<0.01$ ), enjoyment and daily MVPA (Adjusted  $R^2 = .56$ ,  $F=138.29$ ,  $p<0.01$ ), respectively. Discussion Barrier efficacy, though received few attentions in previous studies, was highlighted given the above results. Without barrier efficacy, establishing task efficacy and enjoyment only may not lead to effective adaption and maintenance in PA behavior. Future interventions may consider how to adapt barrier efficacy as a theoretical construct to promote PA behavior. References Evenson, K. R., Catellier, D. J., Gill, K., Ondrak, K. S., & McMurray, R. G. (2008). Calibration of two objective measures of physical activity for children. *Journal of Sports Sciences*, 26(14), 1557-65. Kendzierski, D., & DeCarlo, K. J. (1991). Physical activity enjoyment scale: two validation studies. *Journal of Sport & Exercise Psychology*, 13, 50-64. McAuley, E., & Mihalko, S. L. (2008). Measuring exercise-related self-efficacy. In Duda J. L. (ed), *Advances in Sport and Exercise Psychology Measurement*. Morgantown, VA: Fitness Technology Publishers, 371-390. Contact Shuge Zhang at sug-ar.zhangshuge@gmail.com

### INFIELDERS OF BASEBALL AND SOFTBALL HAVE AN OUTSTANDING PERFORMANCE ON ATTENTION SHIFTING TASK

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**Introduction:** Fielding positions of baseball or softball may have a great impact on the ability of attention shifting for athletes. For example, outfielders may involve less attention shifting than infielders and pitchers during the game because outfielders usually pay more attention on the flying ball, but others have to switch their attention between the flying ball and the runners. This study investigated whether athletes of distinct fielding positions differed in their abilities of attention shifting. Methods: Thirty-seven pitchers (23 male baseball athletes; 14 female softball athletes), 34 infielders (18 males; 16 females), 24 outfielders (13 males; 11 females), and 37 non-athletes (17 males; 20 females) were recruited in this study. Athletes in national levels were undertaking regular training at least 20 hours per week for at least 7 years. Participants were measured with the Covert Orienting of Visual Attention (COVAT) paradigm (Posner, 1980) for testing their ability of attention shifting (simple task). To increase the difficulty of task, we asked participants doing the modified COVAT task by responding with upper- extremities in half trials, and responding with lower- extremities in others (complicate task). The Invalid Cue Effect size (ICE), which was defined as the difference between the median reaction time for invalid and valid trials, was collected to interpret the speed of attention shifting. Three tasks were separately analyzed with a two-way ANOVA, containing groups (pitchers, infielders, outfielders, non-athletes) and genders (male, female) as a between-subject factor, and ICE as the dependent variable. Results: A significant main effect of groups in both simple ( $F(3,124)=3.786$ ,  $p=0.012$ ) and complicated ( $F(3,124)=2.901$ ,  $p=0.038$ ) tasks was found. LSD post-hoc analysis showed the ICE value of infielders was significantly smaller than the non-athletes in the simple task ( $p=0.001$ ). When the task became complex, the post-hoc analysis showed that the infielders had significantly smaller ICE values than pitchers ( $p=0.026$ ) and non-athletes ( $p=0.01$ ). Moreover, the main effect of genders only had significance in the complicated task, not in the simple task. Discussion: The findings revealed that infielders have a better performance in attention shifting than pitchers and non-athletes. This may due to that infielders have to switch their attention from the bat to the location of flying ball, and catch the ball in a limited time. Additionally, males have a better performance than females when the task became difficult, it may represent the simple tasks cannot distinguish their difference of performance in attention shifting. References: Posner M. I., (1980). *Quarterly Journal of Experimental Psychology*, 32(1), 3-25. Contact: BS C. H. Chiang, j00362@hotmail.com

## Mini-Orals

### MO-SH04 Psychology I

#### PHYSICAL ACTIVITY INTENSION MODEL THROUGH EXTRAVERSION AND NEUROTICISM TRAIT OF PERSONALITY AND BODY IMAGE

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*Universitas Gadjah Mada*

**Introduction** Intention is known as motivational factor prior to certain behaviour. Extravertion and neuroticism are hypotesised as the antecedent of intention. Some research about physical activity intension showed that body image might also be a potential factor influ-



encing the intention. Apparently extraversion, neuroticism and body image could altogether predict the intention behind doing physical activity. Theory of Planned Behaviour (TPB) is one of theory invented by Ajzen to explain intention behind behaviour. This study aimed to discover how TPB can effectively explain the relation of body image, neuroticism and extraversion toward physical activity. Model of physical activity intention was proposed. Following Rhodes & Nigg (2011)'s suggestion, subjective norm was eliminated from the model because it was the weakest predictor to explain physical activity intention. Methods Total number of 261 young adults aged 20 to 30 years old were asked to complete online survey which comprised three scales: intention scale, personality scale, and body image scale. Intention scale was developed following Ajzen's theory of intention (TPB) and consisted of three components: attitude toward physical activity, perceived control behaviour, and physical activity intention. The collected data were then analysed using Structural Equation Modelling Results The proposed model in the study was not entirely supported by data ( $\chi^2$  (5, N= 261)= 27.445,  $p = .000$ , CFI =.915, RMSEA=.131). As the model did not show a good fit, some revisions on the model were conducted. Upon some modification was the best model shown with  $\chi^2$  (1, N= 261)= .037,  $p = .847$ , CFI = 1.000, RMSEA=.000 Discussion The hypothetical model proposed was not supported by data because there were variables which were not related to model. The study contradicted Rhodes & Nigg (2011)'s finding which pointed out that neuroticism was related with intention. As opposed to Ajzen's TPB modelling, the study showed that attitude toward behaviour could not explain physical activity intention. Body image as well as two other variables did not directly relate to intention but it could explain intention through PBC. References Rhodes, R.E., & Nigg, C. R. (2011). Advancing physical activity theory: a review and future directions. *Exercise and Sport Sciences Reviews*, 39(3), 113-119

## THE IMPORTANCE OF SELF-REGULATION IN ATHLETE DEVELOPMENT

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Introduction Self-regulation refers to the level of control learners have over their thoughts and behaviour in their own learning environment (Zimmerman, 1986). This is affected by a learner's motivation levels as well as his or her ability to plan, self-monitor, evaluate and reflect throughout the learning process. High levels of self-regulation have been associated with successful performance in a range of domains including academic achievement, music and more recently sport (Jonker et al., 2010, 2011). The aim of this study was to examine the self-regulation skills of Australian athletes from numerous sports, across the developmental spectrum and identify whether elite athletes are distinguishable from their recreational sport counterparts. Methods The Self-regulation of Learning Self-Report Scale (SRL-SRS; Toering et al., 2012) has been found to be a reliable and valid measure of self-regulation in athletes. The SRL-SRS was administered to over 500 Australian able-bodied athletes and athletes with a disability. The cohort included athletes of a recreational level (Foundational 3 FTEM level) and senior elite national level athletes (Elite and Mastery FTEM levels; Gulbin et al., 2013). Results Preliminary findings revealed differences in the self-regulation profiles of athletes across development levels and sports. The results also provided elite benchmarks specific to Australian athletes in the following elements of self-regulation: motivation (self-efficacy and effort), planning, self-monitoring, evaluation and reflection. Discussion The findings provide further evidence of the importance of self-regulation in the development of sport expertise. It is therefore important to monitor and improve the self-regulation skills of developing athletes. Future research should identify effective strategies to improve each of the elements of self-regulation in these athletes. References Gulbin JP, Croser MJ, Morley EJ, Weissensteiner JR. (2013). An integrated framework for the optimisation of sport and athlete development: A practitioner approach. *J Sports Sci*, 31, 319-31. Jonker L, Elferink-Gemser M, Visscher C. (2010). Differences in self-regulatory skills among talented athletes: The significance of competitive level and type of sport. *J Sports Sci*, 28(8), 901-908. Jonker L, Elferink-Gemser M, Visscher C. (2011). The Role of Self-Regulatory Skills in Sport and Academic Performances of Elite Youth Athletes. *Talent Development & Excellence*, 3(2), 263-275. Toering T, Elferink-Gemser M, Jonker L, Heuvelen M, Visscher C. (2012) Measuring self-regulation in a learning context: Reliability and validity of the Self-Regulation of Learning Self-Report Scale (SRL-SRS). *International Journal of Sport and Exercise Psychology*, 10(1), 24-38. Zimmerman BJ. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemp Educ Psychol*, 11, 307-313. Contact Daniel.green@ausport.gov.au

## PSYCHOLOGICAL ASPECTS, INFLAMMATORY AND INJURY BIOMARKERS AFTER THE SÃO PAULO INTERNATIONAL MARATHON

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It is unlikely that the physiological changes completely explain the performance benefits associated with success in a marathon. The performance in a marathon is the result of a conscious effort with the contribution of psychological and motivational factors. The aim of this study was to investigate the mood changes in marathoners after the 2014 São Paulo International Marathon and the relationship with injury and inflammatory biomarkers. Methods: 71 male marathoners, aged 24 to 54 years old were evaluated. Blood samples to analyse creatine kinase (CK), c-reactive protein (RCP), lactate and lactate dehydrogenase (LDH) were collected 24h before and immediately after the marathon. The Brunel Mood Scale (BRUMS) was applied 24h before and immediately after the marathon. Results: The marathoners completed the marathon in  $282.31 \pm 52.9$  minutes. We observed an increase in CK, RCP, lactate and LDH immediately after the marathon comparing with basal values. About the mood scores, tension and stamina decreased after marathon comparing with basal values. Depression, anger, and fatigue increased and confusion did not change. We found a negative correlation between the changes in tension with lactate and CK and between depression and LDH. The increase in anger was positive correlated with RCP. Conclusion: Marathon induces changes in mood scores, which are correlated with physiological changes of injury and inflammatory state. We can conclude the modulation of psychological responses can influence physiological changes and maybe improve the performance.

## THE ROAD TO SUCCESS: ANALYSING THE PROGRESSION OF MALE HANDBALL PLAYERS AND CONSTANT YEAR EFFECT IN DANISH NATIONAL TEAMS.

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The relationship between date of birth and expertise in various sports is well established. The phenomenon is known as the relative age effect (RAE). The International Handball Federation (IHF) has structured international youth tournaments in two-year age cohorts. The difference between the relative youngest and the oldest players is therefore fixed with up to two years of difference in birth date. The constant

difference, which likely creates an effect connected to RAE often called the Constant Year Effect (CYE), may favor the oldest players in selection processes due to increased physical and mental maturity. The Danish Handball Federation (DHF) has implemented the IHF structure with fixed two-year age cohorts in Danish National Teams. Currently, DHF operates with three national teams, namely Y (under 19), U (under 21) and A (senior). The aims of this study were to examine whether or not there was a CYE on the Danish Handball national teams, and to examine the rate of success in DHF talent development. The sample from DHF's database included 244 players, born from 1980-91, whom all participated on at least one national team. The cohorts were divided into 8 birth quarters with quarters 1-4 and 5-8 representing the even and odd years, respectively. Chi Squared analysis was used to determine whether a significant CYE was seen in the selection of players on the Y, U and A national teams, when compared to the expected equal distribution of players across the 8 birth quarters. The number of players who participated on all three national teams and the number of players who participated on Y was used to calculate the rate of success, which refers to the percentage of players who succeeded in being selected for all three national teams. Statistical results were considered significant if  $P < 0.05$ . CYE was significant in the Y ( $P < 0.05$ ) with players born in the 1 and 2 birth quarters being overrepresented, and with players born in the 6, 7 and 8 birth quarters being underrepresented. CYE was also significant at U ( $P < 0.05$ ) with players born in the 1 birth quarters being overrepresented, and with players born in the 8 birth quarters being underrepresented. There was not a significant CYE at the A ( $P = 0.42$ ). The rate of success was 28%, which means that approximately every fourth player who debuts on Y also get their debut at U and A. This is a much higher success rate compared to previous results in Danish Soccer, which is only 3%. The constant year effect was significant in the youth Danish national teams, that is, the selection of players for the youth national team's favors relatively older players rather than younger players. The effect was not significant on the senior national team indicating that the biased selection of players is not repeated at this level. The relatively high success rate of players progressing through all three national teams indicate that DHF has a successful talent development program. Taking steps towards minimizing the CYE in youth national teams would likely increase this success rate.

### **SPORT INJURY PERCEPTIONS AND COPING STRATEGIES: A STUDY WITH MALE YOUTH SOCCER PLAYERS OF BELGIAN ELITE TEAMS**

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*KU Leuven*

**Sport injury perceptions and coping strategies: A study with male youth soccer players of Belgian elite teams**

**Introduction** The purpose of the present investigation was to test the impact of injury perceptions and cognitions on the ways in which athletes cope with the stress of an injury. **Methods** Participants included 72 youth soccer players of a national or international level between 10 and 21 years of age. The team physician approached injured players. Participation was voluntary. They completed the Illness Perception Questionnaire Revised for Sports (van Wilgen, Kaptein & Brink, 2010) and a multidimensional coping inventory (COPE, Carver, Scheier & Weintraub, 1989). **Results** Our results show that a perceived sense of control can be a predictor for adaptive coping mechanisms in injured athletes. The perception of personal and treatment control was associated with active coping, thereby motivating injured players to actively work their way out of their injury. Focus on and venting of emotions as a coping mechanism was mostly predicted by the absence of injury coherence. Injury coherence is the comprehension of every facet of the injury by the injured player. The score on the scale 'emotional representation of the disease' was the best predictor of denial. This means that a strong emotional representation of the disease (e.g. when I think about my injury I get depressed) will lead to more denial as a coping strategy. **Discussion** Injury perceptions and cognitions are related to behavioral responses to the injury. It seems warranted that clinicians are aware of athletes' views about their injuries and communicate about the impact on their coping behavior, in order to increase the chance of an efficient recovery. Our findings support the use of cognitive restructuring interventions for enhancing rehabilitation outcomes. **References** Carver, C., Scheier, M., & Weintraub, J.K. (1989). Assessing coping strategies: a theoretically based approach. *Journal of Personality and Social Psychology*, 56, 267-283. Van Wilgen, P., Kaptein, A., & Brink, M.S. (2010). Illness Perceptions and mood states are associated with injury-related outcomes in athletes. *Disability and Rehabilitation*, 32, 1576-1585.

### **VARIATION OF BURNOUT AND SELF-ESTEEM IN ACCORDANCE WITH SPORTS EXPERIENCE**

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**Introduction** Sports participation contributes to psychological well-being. However, inappropriate constraint from coaches as well as intense physical demands and high psychological pressures can provoke negative consequences for the athletes (Reinboth & Duda, 2005). The aim of this study is to analyse the influence of experience (years training with the same coach and participation in national competition) on self-esteem and burnout in university athletes. **Methods** Participants were 2,413 Mexican university athletes (57.1% men, 39.4% female), aged ranged from 18 to 28 years ( $M = 21.26$ ;  $SD = 1.99$ ) that were engaged in 9 individual sports and 7 team sports. Average time spent with the same coach was 3 years ( $SD = 1.32$ ). Participants fulfilled the Questionnaire Burnout Athlete (Raedeke & Smith, 2001) and the Self-Description Questionnaire (Marsh et al., 1994). **Results** Self-esteem was altered by number of participations in national university ( $F(6, 2200) = 4.40$ ,  $p < .001$ ). Athletes competing for the first time obtained higher scores than those who had been competing for more years ( $p < .01$ ). Moreover, university athletes having spent less than one year with the same coach reached higher self-esteem than those spending one to two years ( $p < .001$ ) and three to four years ( $p < .05$ ). Significant differences were found in burnout by years competing in national events ( $F(4, 1588) = 4.35$ ,  $p < .05$ ), athletes competing for less than five years showing lower levels of burnout than those participating for more than 15 years ( $p < .05$ ). **Discussion** Our findings showed that athletes with less sports experience and years training with the same coach had the best profile in terms of both self-esteem and burnout. These results are in contradiction with previous research (Kristiansen & Roberts, 2009). In our sample, results suggested that the longer athletes spent with the same coach, the more their psychological well-being was negatively affected. Thus, further research should focus on motivational climate and coaches' behaviour during practices and competitions. **References** Kristiansen, E., & Roberts, G.C. (2009). Young elite athletes and social support: coping with competitive and organizational stress in Olympic competition. *Scand J Med Sci Spor*, 20, 686-695. Marsh, H.W., Richards, G.E., Johnson, S., Roche, L. & Tremayne, P. (1994). Physical self-description questionnaire: Psychometric properties and a multitrait-multimethod analysis of relations to existing instruments. *J Sport Exercise Psy*, 16, 270-305. Raedeke, T., & Smith, A. (2001). Development and preliminary validation of an athlete burnout measure. *J Sport Exercise Psy*, 23, 281-306. Reinboth, M., & Duda, J.L. (2005). Perceived motivational climate, need satisfaction and indices of well-being in team sports: A longitudinal perspective. *Psychology of Sport and Exercise*, 7, 269-268. Contact Corresponding author: Abril Cantú-Berrueto. Email: psico.acb@gmail.com

## BURNOUT CORRELATES IN GRASSROOTS FOOTBALL COACHES: PERFECTIONISM AND UNCONDITIONAL SELF-ACCEPTANCE

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Unidad de Investigación de Psicología del Deporte. University of Valencia (Spain) Introduction Burnout might have adverse consequences for coaches but also, via implications for their interactions, can affect the quality of the sport experience of athletes. Consequently, understanding the antecedents of this negative emotion is of great interest in the sport context. Hill, Hall, Appleton and Kozub (2008) have proposed that perfectionism could be a vulnerability factor for burnout in athletes and that unconditional self-acceptance would mediate this relationship. In this study, focused on grassroots coaches, and based on Hill et al. (2008), two objectives were pursued: (1) to examine the influence of self-oriented (SOP) and socially prescribed (SPP) perfectionism on burnout, and (2) to examine whether the association between perfectionism and burnout is mediated by unconditional self-acceptance (USA). Participants Participants were 124 grassroots coaches (114 male and 10 female) from 28 football clubs of Spain, between 17 and 60 years old ( $M=31.05$ ;  $SD=10.48$ ). Participants completed a questionnaire package tapping the variables of interest. Results As expected, correlational analyses indicated that both SPP and SOP were positively related to burnout and negatively related with USA. USA was negatively associated with burnout. Results of path analysis demonstrated a poor fit of the data ( $\chi^2=20.73$ ;  $SRMR=0.12$ ;  $IFI=0.84$ ;  $CFI=0.83$ ). Following modification indices a direct path from SPP to burnout was added. The revised model revealed a good fit of the data ( $\chi^2=0.76$ ;  $SRMR=0.02$ ;  $IFI=0.99$ ;  $CFI=1.00$ ). The standardised path coefficients indicated a significant direct positive path from SPP to burnout ( $B=0.45$ ) and also revealed a significant indirect path from SPP to burnout via a negative association with USA ( $B=-0.22$ ), supporting partial mediation. The model also showed a significant indirect path from SOP to burnout via a negative association with USA ( $B=-0.39$ ). As expected, a significant negative path from USA to burnout was observed ( $B=-0.18$ ). Discussion With some exceptions, results of this study with grassroots coaches are similar to those obtained with junior elite soccer players in the research of Hill et al. (2008). This study provided support for the role of USA as a partial mediator of the relationship between SPP and burnout and a total mediator of the association between SOP and burnout. Findings suggest that both dimensions of perfectionism may be critical antecedents of burnout in grassroots coaches and that unconditional self-acceptance can reduce the impact of perfectionism on coaches' burnout symptoms. References Hill, AP, Hall, HK, Appleton, PR, Kozub, SR (2008). Perfectionism and burnout in junior elite soccer players: The mediating influence of unconditional self-acceptance. *Psychol Sport Exerc*, 9, 630-644. Contact Email: Isabel.Castillo@uv.es

## EXERCISE FOR CLINICAL DEPRESSION: A SYSTEMATIC REVIEW ANALYZING SEVERAL QUESTIONS

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Introduction The goals of the present study were to analyze characteristics of physical exercise (PE) programs of published studies, independently of the results obtained; in other words, whether PE programs had significant effects in the decrease of depressive symptomatology or not. This paper also intends to analyze many questions, which should be taken into account in future trials. Detailed approach focusing several questions, such as: (a) how are participants recruited into trial, (b) which scales should be chosen to measure the severity of depressive symptoms, (c) which are the recommendations to prescribe physical exercise for patients with depression, (d) the importance of analyzing changes in physiological markers, body composition and functional capacity before and after the PE intervention, (e) discuss the use of the potential anti-depressant effect in relation to the placebo groups. Answers to these questions could be a potential contribution for understanding the effects of PE as a therapeutic approach for patients with depression. Methodology The databases PUBMED, CINAHL, MEDLINE, PSYCINFO, PSYARTICLES and COCHRANE DATABASE were searched (2003-2014). Results Fourteen references fulfilled the broad inclusion criteria, and the methodological evaluation according to PEDro scale (Sherrington, Herbert, Maher, & Moseley, 2000) revealed that 93% of the studies met 50% score over or equal to 6. A total of fourteen randomized controlled trials (RCTs), which met the inclusion criteria, were reviewed and ten (71.4%) of them reported a significant contribution effect in the treatment of depression. Discussion / Conclusion New RCTs with new designs are needed to assess the efficacy of the PE intervention. Future trials should (a) recruit patients into trials referred from general practitioners or psychiatrists, (b) opt for scales used to measure the severity of depressive symptoms according to the questions that researchers want to clarify, (c) adopt PE programs with new trial designs that apply principles of training, (d) assess physiological markers, body composition and physical functions before and after the PE intervention as it is crucial to test the effectiveness of a PE program, and (e) clinical trials that used PE as a placebo group must be carefully analyzed. It is hoped that this review could be seen as stimulation to improve methodological quality of future researches based on the questions and answers made. References Sherrington, C., Herbert, R. D., Maher, C. G., & Moseley, A. M. (2000). PEDro. A database of randomized trials and systematic reviews in physiotherapy *Manual Therapy* (Vol. 5, pp. 223-226). Scotland. E-mail: larafcarneiro@gmail.com

## Mini-Orals

### MO-PM07 Adapted physical activity: Challenges

#### AEROBIC 3-MONTH PHYSICAL ACTIVITY PROGRAM IN BREAST CANCER SURVIVORS: EFFECTS ON SLEEP BEHAVIOR, ANTHROPOMETRIC INDICES OF ADIPOSITY AND FASTING GLUCOSE METABOLISM.

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1 UNIMI, Milan, Italy. 2 INT, Milan, Italy. 3 IRCCS Policlinico San Donato Milanese, Milano, Italy. Background: Evidences exist that sleep disorders are associated with an increased risk of cancer, including breast cancer (BC) (Verkasalo et al., 2005). Also adiposity and hypersulinemia have been acknowledged as factors involved in cancer mortality including BC (Pisani, 2008). Physical activity (PA) has the potential to counterbalance all of these risk factors. In fact, PA has been shown to produces beneficial effects on sleep quality and BC prognosis, as well as on adiposity and glucose metabolism (Mann et al., 2014). We thus designed a randomized controlled trial to test the effect of an aerobic PA program on sleep behavior, anthropometric indices of adiposity and fasting glucose metabolism in BC women included in a dietary intervention trial for prevention of BC recurrences. Subjects and Methods: 42 BC women, aged 35-70 years, were

randomized into an intervention (IG=19) and control group (CG=23). The IG had to participate in a 3-month active PA program that included two sessions of one-hour brisk walking per week. At baseline and after 3-month, all women were requested to undergo an anthropometric visit, to collect a blood sample for determination of fasting insulin and glucose levels, to wear the Actigraph Actiwatch for one week for sleep parameters evaluation (Actual Sleep Time (AST), Actual Wake Time (AWT), Sleep Efficiency (SE); Sleep Latency (SL); Mean Activity Score (MAS); Movement and Fragmentation Index (MFI) and Immobility time (IT)). Results: At the end of the 3-month PA program, CG showed an overall worsening of sleep behaviour. In fact, SE, IT and AST decreased ( $p<0.01$ ), while AWT, MAS and MFI increased ( $p<0.01$ ). In contrast, IG did not show any sign of sleep deterioration. As for the indices of adiposity, a significant reduction in waist circumference ( $p<0.05$ ) and % fat mass ( $p<0.01$ ) was observed in IG, but not in CG. Although fasting glucose and insulin levels did not show any significant change in either group, it was nevertheless encouraging that the two groups displayed an opposite trend as far as the changes in fasting insulin were concerned: fasting insulin showed a mean reduction ( $-0.9 \mu\text{U}/\text{ml}$ ) in the IG group and a mean increment in the CG ( $+0.7 \mu\text{U}/\text{ml}$ ). Conclusion: Our results suggest that a standardized PA program in BC survivors prevents sleep deterioration, reduces anthropometric indices of adiposity and may prove useful in preventing the development of hyperinsulinemic levels. REFERENCES 1. Mann et al. (2014). *Diabetes Metab Res Rev.* 30: 257-268 2. Pisani P. (2008). *Arch Physiol Biochem* 114: 63-70. 3. Verkasalo PK et al. (2005). *Cancer Res* 65(20): 9595-600.

### DEVELOPMENT OF A TWO-PART EXERCISE MODEL TO ENHANCE PHYSICAL ACTIVITY LEVELS IN PEDIATRIC CANCER PATIENTS DURING ACUTE CANCER TREATMENT

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**Introduction** Reduced physical activity levels in children with cancer (Winter et al. 2009) additionally increase the cancer-related burden and presumably lead to further persisting problems like reduced motor performance (Götte et al. 2015). The first objective was to evaluate the current need of exercise interventions by comparing intra-individual physical activity levels before and during treatment and evaluating patient-related barriers and motivations with respect to exercise. Furthermore, we developed a two-part model to promote physical activities during hospital stays and at home. **Methods** Physical activity levels were assessed with a standardized physical activity questionnaire in 130 pediatric cancer patients (aged  $12.2\pm 4.7$  years; 61% male;  $3.0\pm 1.6$  months since diagnosis, mixed tumor entities). Patients' opinions, barriers and motivations regarding exercise were assessed in a qualitative approach with guideline interviews in 40 pediatric cancer patients (aged  $13.2\pm 4.1$  years; 53% male;  $5.5\pm 2.3$  months since diagnosis, mixed tumor entities). Results Daily physical activities (walking, playing) and minutes of exercise per week decreased significantly during treatment ( $p<0.001$ ). The most pronounced reductions in physical activities were identified for bone tumor patients, older age and hospital stays in which 50% of the patients left their bed for  $<1\text{h}/\text{d}$ . In the interviews the patients emphasized the importance of supervised training sessions and individual support in order to be motivated for exercise. **Discussion** These results underline the importance of individually-tailored and supervised exercise programs during treatment. Therefore, we are currently evaluating a two-part model to enhance physical activity levels. This model consists of 1) a supervised exercise intervention during hospital stays and 2) a personal training plan comprising individual goals and exercises for home stays. An activity tracker (fitbit) provides feedback about daily steps during home stays and regular contact (by email, phone, face-to-face) ensures support and safety. References Winter C, Müller C, Brandes M et al. (2009). *Pediatr Blood Cancer*, 53, 438-43. Götte M, Kesting SV, Winter CC et al. (2015). *Eur J Pediatr* [Epub ahead of print]. Contact Miriam.goette@ukmuenster.de

### IMPACT OF A SOCIAL MEDIA EXERCISE SERVICE ON PHYSICAL FITNESS, PHYSICAL ACTIVITY, WELLBEING AND BODY WEIGHT

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**Introduction.** Previous studies have demonstrated that inactivity is one of the biggest challenges for health promotion in the world. According to the World Health Organization, sedentary behavior is currently the fourth leading risk factor for premature mortality (WHO, 2010). All tools that increase physical activity among people around the world are useful including social media exercise services. The purpose of the present study was to investigate the impact of a social media platform on physical fitness, physical activity, wellbeing and body weight among users of a social media exercise service. **Methods.** The subject group consisted of 2862 male ( $n=799$ , 27.2 %) and female ( $n=2083$ , 72.8 %) service users (HeiaHeia) that voluntarily participated in the web survey (SurveyMonkey, Palo Alto, California, USA). Surveys were available for the service users for a period of one month on the HeiaHeia web page. Age, gender, body mass index, physical fitness and activity information were self-reported for background information. Changes in physical fitness, physical activity, wellbeing and body weight of the users were also self-estimated. **Results.** Most service users (78.1%) exercised more than three times a week. About 75% of the users reported to be at least in good physical fitness and about 50% were overweight. Almost half of the service users (46.4%) reported that use of the social media had advanced their perceived physical fitness, and more than half (64.6%) reported that their perceived physical activity increased due to use of the service. In addition, 54.0% of the users responded that their perceived well being increased. Every fifth (21.3%) service user reported decreases in their body weight as a result of using the service. Users with lower physical fitness, lower physical activity and overweight were more likely to report that use of this online service was useful when compared to their more active counterparts. **Discussion.** Use of this social media exercise service seems to lead to improvements in physical fitness, increases in physical activity and enhanced wellbeing. In addition, HeiaHeia had a positive impact on users' body weight. Use of this social media service is especially well-suited for overweight, unfit and sedentary customers. In conclusion, it is important to have targeted marketing campaigns to get more inactive and overweight people interested in these kinds of services. References. WHO Library Cataloguing-in-Publication Data Global status report on noncommunicable diseases 2010. ISBN 978 92 4 068645 8. Do not insert authors here

### ETHNIC DIFFERENCES IN MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY IN PREGNANCY AND POSTPARTUM

Richardsen, K.R.1,2, Jenum, A.K.2,3, Berntsen, S.4

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University of Agder (Kristiansand, Norway). Introduction: Analyses of objective data on moderate-to-vigorous physical activity (MVPA) in pregnancy rarely cover MVPA accumulated in bouts. We aimed to compare MVPA minutes per day (min/day) accumulated in bouts  $\geq 10$  minutes (MVPA bouts) and total MVPA accumulation (total MVPA) during pregnancy and postpartum across four ethnic clusters. Methods: Data originate from the Stork Groruddalen Cohort study (Oslo, Norway) which included 823 pregnant women between 2008-2010. Data was collected at three visits (V1-3) at local child health clinics; before 21 (V1) and at 28 (V2) weeks' gestation, and, three months postpartum (V3). Following each visit free-living MVPA minutes were recorded with SenseWear™ Pro3 Armband (SWA). Women were asked to wear the SWA over 4 days, and only remove it during water activities. Ethnicity was reported in interviews and categorised as South Asian, Middle Eastern, Western and other. Results are presented as median min/day. Ethnic differences in MVPA were analysed with Kruskal-Wallis. Results: The sample consisted of 327 women with  $\geq 1$  day at each visit with  $\geq 19.2$  hours of SWA wear time. The sample was younger, had lower bmi, and higher proportion with Western background and university education compared with the remaining cohort. Median values dropped from V1 to V2 for total MVPA (70 to 57 min/day) and bouts (15 to 9 min/day). At V3, medians for total MVPA and bouts had risen to 73 and 18 min/day, respectively. Differences between ethnic clusters were significant only for MVPA bouts; at all visits South Asian and Middle Eastern women recorded fewer min/day than Western women. At V1, V2 and V3 Western women spent 20, 12 and 26 min/day, respectively. For South Asian women at V1, V2 and V3 the difference was -11 ( $p=0.002$ ), -6 ( $p=0.01$ ) and -18 ( $p<0.001$ ) min/day, respectively. For Middle Eastern women the difference was -10 ( $p=0.03$ ), -8 ( $p=0.01$ ) and -19 ( $p<0.001$ ) min/day. Discussion: Estimates of MVPA min/day are influenced by whether bouts or total MVPA are considered. The differences between bouts and total MVPA underlines the need for a consensus on how to operationalize objective measures of MVPA in research. The results suggests South Asian and Middle Eastern women are at increased risk of low levels of MVPA bouts. Promotion of MVPA in these groups must build on insight into underlying behavioural determinants of MVPA. E-mail: kareri@hioa.no

## Mini-Orals

### MO-BN04 Mixed

#### BIOMECHANICAL ASSESSMENT OF SWISS PRESS HANDSTAND TECHNIQUE IN COLLEGIATE MALE GYMNASTS.

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Introduction Swiss press handstand movement is one of the fundamental techniques as the element which is necessary for all items except vaulting in gymnastics. Biomechanical mechanism of static handstand balance was reported by Kerwin[1] and Yeadon[2] till now, but swiss press handstand technique is not clear. The purpose of this study was to investigate swiss press handstand technique by using joint kinetics in collegiate male gymnasts. Methods Eleven male collegiate gymnasts (Age:  $19.1 \pm 1.5$  yr, BH:  $164.5 \pm 6.6$  cm, BW:  $62.6 \pm 6.1$  kg) were participated in this study. Each subject performed swiss press handstand movement on a force plate (Kistler, 1kHz) and kinematics data was recorded by high-speed camera (Basler, 100fps). Reflective marker were attach on the subject's anatomical landmark points. Center of mass (COM) was calculated by using Dempster [3] body segment data. Joint kinetics data (Wrist, Shoulder, Hip) were calculated from 2D inverse dynamics methods to refer the preliminary research in Yeadon, 2003[2]. Athletics performance of swiss press handstand movement were judged by the person who has physical exercises experience more than ten years, and subjects were divided into two groups (Skill: five subjects, Unskill: six subjects). Duration of swiss press handstand movement was normalized from toe-off to handstand. All statistical analysis were used by student's t-test (welch) performed on selected means to detect significant differences (effective  $P < 0.05$ ) between Skill and Unskill (JMPver. 8.0 : SAS inc.). Results and discussion Larger shoulder angle were observed in Skill (Skill:  $139.9 \pm 5.4$  deg VS UnSkill:  $131.5 \pm 3.1$  deg,  $P < 0.05$ ). Skill indicated large wrist palmar flexion torque than Unskill during movement ( $P < 0.05$ ). On the other hand, Unskill's shoulder extension torque was larger than Skill ( $P < 0.05$ ). Hip torque, in particular, showed great difference between Skill and Unskill throughout toe-off to finish. Skill indicated hip torque changes from flexor to extensor one, however Unskill indicated only hip flexor torque. Although wrist strategy as wrist palmar flexion torque plays an important role in a handstand [1,2], swiss press successful technique was different between Skill and Unskill, in particular larger shoulder extension at toe-off may be important movement to use hip torque effectively. Conclusions Technical factor developing hip extensor torque is important in swiss press handstand and this might be caused by the flexibility of a shoulder joint. References [1] Kerwin, D.G. & Trewartha, G. (2001) Strategies for maintaining a handstand in the anterior-posterior direction. Med. Sci. Sports Exerc., 33(7), 1182-1188 [2] Yeadon, M.R. and Trewartha, G., (2003). Control strategy for a hand balance. Motor Control, 7 (4), 411-430 [3] Dempster, W.T., (1955) Technical Report WADC-TR-55-159. Wright Patterson Air Force

#### SPRINGY BEHAVIOR OF THE LONGITUDINAL FOOT ARCH DURING ANKLE BENDING EXERCISE AT DIFFERENT MOVEMENT FREQUENCIES

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Introduction The longitudinal foot arch constitutes various elastic structures that serve as a spring in human locomotion (Alexander, 1991). The behavior of elastic structures in a muscle-tendon unit (i.e. tendinous tissues) depends on movement frequency under stretch-shortening cycle movements (Sakuma et al., 2012). This study aimed to investigate the influence of the frequencies of ankle bending exercise on the springy behavior of longitudinal foot arch. Methods Seven male volunteers performed ankle bending exercise at two movement frequencies (0.5 and 2.0 Hz) on a sledge apparatus which was inclined by  $30^\circ$  from the horizontal direction. Five reflective markers (anterior tip of first metatarsal bone, anterior vertex of talus, calcaneal tuberosity, and two markers on the tibia to define its longitudinal direction) were captured by a video camera at 300 fps. The height of longitudinal foot arch was determined as the perpendicular distance from the anterior vertex of talus to the line connecting the anterior tip of first metatarsal bone and calcaneus tuberosity. The compression load on the longitudinal foot arch was calculated from the ground reaction force on the ball of the foot recorded by a force plate operating at 2,000 Hz. The relationship between the change in the height of the longitudinal foot arch and the compression load was used to estimate the elastic strain energy stored and released in the longitudinal foot arch. Results and Discussion The changes in the height of the longitudinal foot arch were similar over the two movement frequencies (0.5 Hz:  $18.6 \pm 3.3$  mm, 2.0 Hz:  $19.3 \pm 6.5$  mm),

while the compression load at 2.0 Hz ( $2045 \pm 452$  N) was significantly larger than that at 0.5 Hz ( $330 \pm 69$  N). Thus, the longitudinal foot arch behaved as a stiffer spring at higher frequency. The elastic strain energy stored in the longitudinal foot arch in the dorsiflexion phase at 2.0 Hz ( $12.1 \pm 5.4$  J) was significantly larger than the corresponding value at 0.5 Hz ( $3.3 \pm 1.5$  J). The elastic strain energy stored in the dorsiflexion phase was almost identical to those released in the plantar flexion phase both at 0.5 and 2.0 Hz, suggesting no energy dissipation in the longitudinal foot arch during the present exercise regardless of movement frequencies. These results strongly suggest that the longitudinal foot arch plays an important role as a spring under a stretch-shortening cycle movement, the role being greater at higher frequency. References Alexander RM. (1991). *J Exp Biol.* 160, 55-69. Sakuma J, Kanehisa H, Yanai T, Fukunaga T, Kawakami Y. (2012). *Eur J Appl Physiol.* 112(3), 887-98. Contact s-iwanuma@ntu.ac.jp

### RUNNING PATTERN ADJUSTMENTS DURING UNWEIGHING AND RELOADING TRANSITION PHASES

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**Introduction** As gravity plays an essential role in terrestrial locomotion, several studies have investigated the effects of reducing gravity on locomotion kinematics and kinetics (for a review, Sylos-Labinis et al. 2014). On a lower body positive pressure (LBPP) treadmill, 3 min of unweighing have been demonstrated to be sufficient for updating the running pattern (Sainton et al., 2015). The present study focused on the adjustments during the unweighing and the reloading transition phases. **Methods** Seven healthy males (mean age: 21.7 years  $\pm$  3.6; body height: 172.7 cm  $\pm$  5.7; body mass: 64.6 kg  $\pm$  7.5) performed 2 randomized treadmill running series at preferred speed. Each series included 3 successive running conditions of 3 min [at 100 % body weight (BW), either 60 or 80 % BW, and 100 % BW]. Vertical ground reaction forces, center of mass accelerations and treadmill chamber pressure were analyzed for each of the successive left and right steps. The analyses concentrated on the temporal and kinetics changes during the 10-15 s transition phases as compared to their mean values during the preceding stable state. **Results** Amongst all measured parameters, only a few changed significantly and in a reversed way during the unweighing and the reloading phases. For instance, from the start of the unweighing transition, the active peak force and mean push-off impulse decreased progressively while the flight and stride durations increased. The contact time was remarkably stable. The braking impulse also remained stable, except in the reloading phase from 60% BW where it increased. The impact peak force showed large inter-individual variability. **Discussion** This study of the transition phases during LBPP treadmill running confirmed the existence of both stable and varying parameters after 3 min of unweighing and reloading as reported by Sainton et al. (2015). The progressive changes of the active peak force, mean push-off impulse, flight and stride durations were mostly attributed to the pressure variations inside the treadmill chamber. The consistency of the contact time despite unweighing differs from the predictions by the linear mass-spring model of the body and leg (McMahon and Cheng 1990). This could result from the modified leg length at impact and take-off once the chamber is inflated (He et al. 1991). However, the lack of similarities between the braking and push-off impulse changes supports their distinct regulation through muscle activation (Sainton et al. 2015). References Sylos-Labini F, Lacquaniti F, Ivanenko YP (2014). *Bio Med Res Int Hindawi* ID 547242. He JP, Kram R, McMahon TA (1991). *J Appl Physiol* 71:863-70. McMahon and Cheng (1990). *J Biomech* 23(Suppl 1):65-78. Sainton P, Nicol C, Cabri J, Barthelemy-Montfort J, Berton E, Chavet P (2015). *Eur J Appl Physiol* (in press). Contact pascal.chavet@univ-amu.fr

## Mini-Orals

### MO-PM06 Adapted physical activity: Sport & disability

#### CARDIORESPIRATORY RESPONSE DURING WHEELCHAIR DANCE AND AUTONOMOUS REGULATION IN BEDRIDDEN INDIVIDUALS

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**Introduction** Aerobic fitness (assessed by oxygen pulse during dance) was not improved by wheelchair dance exercise for 5 to 15 min at a time, more than 3 times a week, for 6 months in 7 individuals with cerebral palsy rated in GMFCS (Gross Motor Function Classification System) level V (averaged  $54 \pm 10.0$  years old) (Terada, et al., 2014). The aim of this study was to evaluate the heart rate variability right before and right after the wheelchair dance in bedridden individuals. **Methods** The participants were 4 individuals with cerebral palsy rated in GMFCS level V (41 to 66 years) and an 11 year old participant with Fukuyama muscular dystrophy (FMD). Heart rate (HR) and oxygen uptake ( $VO_2$ ) were measured during rest, the waltz, the jive, and rest again for 5 min respectively. **Results** HR and  $VO_2$  were slightly increased during the waltz and the jive in 3 individuals with cerebral palsy, and the ratio of low frequency power to high frequency power (LF/HF) was also slightly increased right after the dance. A 45 year old participant with cerebral palsy looked very relaxed and showed little change in HR and  $VO_2$  during the dance and LF/HF right after the dance was decreased. In contrast, HR and  $VO_2$  were increased in the waltz, and were markedly increased in the jive in the FMD participant. LF/HF was also markedly increased right after the dance. **Discussion** Although she was not with cerebral palsy but with FMD, the youngest participant showed high LF/HF right after the dance as well as good cardiorespiratory responses during the dance being different from other older participants with cerebral palsy. While there are few reports on autonomous regulation in bedridden individuals, it was reported that the autonomous nervous system would fail to keep blood pressure steady with heart rate being increased when a long term bedridden individual was placed into lower body negative pressure (Mita, et al., 1994). Therefore, it may be possible that long term recumbency would also harm the individual's autonomous regulation on cardiac function while wheelchair dance to expect positive effect of wheelchair dance on cardiorespiratory fitness. It may be important to consider to commence physical activity programs like wheelchair dance for bedridden individuals as soon as possible. References Terada K, Satonaka A, Terada Y, Suzuki N. (2014). Training effect of wheelchair dance on aerobic fitness in bedridden individuals with severe cerebral palsy. 7th World Congress of Biomechanics. Mita K, Akataki K, Itoh K, et al. (1994). Hemodynamic and hormonal changes during lower body negative pressure in bedridden disabled patients. *Sports Med Training and Rehab*, 3, 147-156

## COMPARISON OF ADAPTIVE AND COMPETITIVE SWIMMING INSTRUCTIONS

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**Introduction** The social demands on swimming has been changing, and, as a consequence its goals as well. The dominance of the previous aim has been relayed by health recuperation, preservation and development. These new aims made it necessary to re-think swimming categories and, as a consequence, competitive swimming, recreation swimming and adaptive swimming were separated from each other. Different aims of swimming require different instructing activities. Therefore the aim of this study was to analyse two different kinds of instructions, namely the competitive and adaptive ones. Are there any differences between the instructions during the two types of swimming? And if so, which ones? **Methods** To answer the above questions we applied the method of written questioning, questionnaires, and Cheffers' (1973) adaptation of categorical observation. The samples were provided by qualified swimming instructors ( $N_a=8$ ,  $N_u=8$ ) and children attending adaptive swimming lessons ( $N_a=147$ ,  $N_u=140$ ). We applied 21 teaching categories (Table 1) using Bíró's system of categories (Bíró et. al. 2007) who adapted the FIAS (Flanders, 1965), the CAFIAS (Cheffers, 1983) and the modified versions of Svoboda's (1977) observation systems in his research. **Results** On the basis of our results it can be stated that there is a significant difference between instruction activities in adaptive and competitive swimming lessons, and, on the other hand, the atmosphere is also different. Teaching methods like explanation, fault correction, assistance and praising appeared in a higher proportion during adaptive swimming lessons than in the course of competitive swimming lessons. Regarding the atmosphere of training sessions, a more informal, more relaxed mood could be experienced in the case of adaptive swimming compared to competitive swimming. **Discussion** As a consequence of the above mentioned results we can state that instructors of adaptive swimming should adopt a different approach and attitude as children taking part in adaptive swimming lessons are quite sensitive and have different personality types compared to the participants of competitive swimming training sessions; and they often become marginalized in their age group due to their particular disabilities. **References** Bíró M, Bíróné N.E, Fügedi B, Révész L, Szabó B. (2007). Examination of teaching – learning process in swimming applying Chaffers' system of interaction categories. *Educational Research and Reviews* 2/4 pp. 064-073. Cheffers JTF. (1983): Cheffer's Adaptation of the Flanders' Interaction Analysis System (CAFIAS). In: Darst P, Mancini V, Zakrajsek D (Eds.), *Systematic Observation Instrumentation for Physical Education*. Leisure Press, pp.76-96. Simon I, Bucsyné G. (2008). Az úszás cél- és feladatrendszerének változása napjaink társadalmi elvárásainak tükrében. *Képzés és Gyakorlat* 6/2. pp. 36-44. Contact bokorju@mnsk.nyme.hu or not insert authors here

## FUNDAMENTAL MOVEMENT SKILLS MASTERY OF BOYS WITH AND WITHOUT INTELLECTUAL DISABILITY IN THE PHILIPPINES

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**Introduction** In the Philippines, children with intellectual disability (ID) attend special schools where limited time is allocated for physical education (PE) and motor skills training. Recent studies from developed regions show that fundamental movement skills (FMS) of children with ID are less proficient relative to typically developing (TD) peers (Westendorp et al., 2011). However, the proportion of children with ID who display FMS mastery has yet to be examined. Such evidence is important to identify the need for FMS programs, but is currently limited in developing countries. This study aimed to compare the FMS mastery of children with and without ID in the Philippines, focusing on boys who make up the majority of special schools' enrollment in the country. **Methods** Participants include boys with ID ( $n=56$ ; mean age =  $7.95 \pm 0.82$  years) and an age-matched TD group ( $n=84$ ; age =  $7.65 \pm 0.91$  years). FMS proficiency was tested using ten components of the Test of Gross Motor Development-2 (Ulrich, 2000). Locomotor skills included run, hop, leap, horizontal jump and slide, while object control skills included dribble, catch, kick, overhand throw and underhand roll. Raw scores and percentage of mastery for each skill component were calculated. **Results** Multivariate analysis of variance showed a significant effect of disability ( $F(2,132)=67.74$ ,  $p<.001$ ,  $\eta^2=.51$ ) on both locomotor and object control skills. Participants with ID had mean scores of 22.07 ( $SE=.98$ ) for locomotor, and 18.66 ( $SE=.75$ ) for object control skills. The TD group had mean scores of 31.81 ( $SE=.82$ ) for locomotor, and 30.16 ( $SE=.15$ ) for object control skills. Analysis of each skill component showed that locomotor skills mastery ranged from 4% to 38% for those with ID, and from 19% to 80% for the TD group with jumping least mastered by both groups. Object control skills mastery ranged from 2% to 7% for those with ID with throwing least mastered; and from 24% to 60% for the TD group with rolling least mastered. Chi-square tests showed that mastery levels for all skills were significantly lower for the ID group relative to the TD group (all  $p<.05$ ). **Discussion** Boys with ID displayed lower FMS mastery relative to TD peers, providing evidence that underpins the value of FMS training programs for children with ID. Specifically, object control skills were found to have larger differences in mastery between the two groups. An important contribution of this study is the population-specific evidence that would serve as an impetus for special schools in the Philippines to address motor development via adapted PE curricula. **References** Westendorp M, et al. (2011). *Res Dev Disabil*, 32(3), 1147-53. Ulrich D. (2000). Texas: Pro-Ed.

## THE EFFECTS OF SKIN SCUBA PROGRAM ON CONCENTRATION AND SELF-REGULATION OF AUTISTIC CHILDREN

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**Introduction** It is well known that autistic children have social problems such as self-regulation, concentration and adaptive behaviour (APA, 2000; Kogan et al., 2009). The purpose of this study is to investigate how skin scuba program affects self-regulation, concentration and adaptive behavior of autistic children and to provide baseline data on making a variety of programs for training and rehabilitation facility for autistic children. **Methods** A total of 20 children with autism were recruited for this study. The participants were divided into two groups; ten for the experimental and ten for the control group. The experimental group participated in scuba diving twice a week, on every Wednesday and Saturday for 2 hour sessions, 8 times a month for 4 months, totalling up to 32 sessions. Psychological measurements were taken pre and post participation in the scuba diving program. Results Two way repeated measures ANOVA was carried out on all the variables with SPSS (version 21). The results for the cognitive regulation and the emotional regulation, sub-areas of self-regulation, were improved in the experimental group. There were no statistical differences in the selective attention and the self-regulation, sub-areas of concentration. Finally for the conceptual adaptive behavior, the social adaptive behavior and the practical adaptation actions, sub-areas of adaptive behavior, there were significant improvements in the experimental group. **Discussion** The results of this study suggest that the participation in a skin scuba program may affect the on self-regulation, concentration and adaptive behavior of autistic children. This study provides empirical evidence supporting the participation of a skin scuba program for children with autism

for exercise and rehabilitation training. References American Psychiatric Association. (2000). Diagnostic and statistical manual of mental disorders. Washington. Kogan MD, Blumberg SJ, Schieve LA, Boyle CA, Perrin JM, Ghandour RM., et al. (2009). Pediatrics, 124, 1395-1403. Contact: yshwang@pusan.ac.kr

## Mini-Orals

### MO-PM11 Health & Fitness: Age

#### CHANGES IN FIRE FIGHTER FITNESS AND PERFORMANCE OVER AN 18 YEAR PERIOD

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**Introduction:** Firefighting is a demanding occupation that requires a high level of physical fitness and job performance. As firefighters age they may experience changes in both fitness and performance. Aging may be associated with decreases in muscle strength, endurance, and cardiovascular fitness. Job performance that is related to physical fitness (FFJP) may also be compromised. The scientific literature indicates that men in general lose 40% of their muscle mass with a 30% decrease in strength by age 70 (Rogers & Evans, 1993). Maximal oxygen uptake decreases approximately 9% per decade for sedentary men (Elia, 1991). The purpose of this investigation was to evaluate firefighter fitness and performance over an 18 yr. period. **Methods:** Twenty-four firefighters were evaluated in 1996 and again 18 years later in 2014. They were evaluated for the following: height, weight, maximal push-ups, maximal sit-ups, 1.5 mile run, and simulated job performance (FFJP). Each fire fighter performed a maximal FFJP test, wearing turnout gear and self-contained breathing apparatus (SCBA). The FFJP test consisted of the following: stair climb, hoist, forcible entry, hose drag, and dummy drag. A paired T-test was performed to evaluate changes physical fitness and job performance over time ( $p < .050$ ). **Results:** The respective pre and post mean  $\pm$  SD values were: age (yrs.)  $27.75 \pm 4.14$  &  $45.79 \pm 3.62$ , height (m)  $1.77 \pm 0.06$  &  $1.77 \pm .07$ , weight (kg)  $79.75 \pm 9.39$  &  $90.32 \pm 11.90$ , push-ups  $48 \pm 12$  &  $50 \pm 20$ , sit-ups  $44 \pm 8$  &  $47 \pm 8$ , and 1.5 mile run (min)  $11.31 \pm 1.6$  &  $12.78 \pm 1.53$ . The FFJP times were  $4.18 \pm 0.67$  &  $5.55 \pm 1.47$  (min). Results indicated that there were significant differences in fitness and performance over time. Age increased  $18.04 \pm 1.62$  yrs. ( $p = .000$ ), no significant change in height ( $p = .497$ ), weight increased  $10.56 \pm 8.80$  kg ( $p = .000$ ), no significant change in push-ups ( $p = .622$ ) or sit-ups ( $p = .162$ ), 1.5 mile run times were slower  $1.47 \pm 1.97$  min ( $p = .015$ ), and FFJP was slower  $1.36 \pm 1.32$  min ( $p = 0.000$ ). The percent changes over time were: weight + 13%, push-ups + 4.26%, sit-ups + 6.82%, 1.5 mile run time + 13%, and FFJP + 32%. **Conclusions:** This investigation found changes in fitness and performance variables over time. The major changes were related to cardiovascular fitness, weight, and job performance. Muscular strength and endurance did not significantly change. It should be noted that the Montgomery, AL Fire and Rescue Department has a mandatory fitness and weight control program for all firefighters. The ability of the firefighters to maintain their strength and endurance was likely related to the fitness program and the leadership of the department. Weight increased 0.58 kg per year and cardiovascular fitness decreased 13% over an 18 year period. While the job task performance times were slower, they were still well within acceptable standards. Results indicate that it is important for fire departments to monitor changes in physical fitness and performance related to the aging process.

#### DIVERSITY OF ADOLESCENTS' SPORT PARTICIPATION AS A PREDICTOR OF LEISURE-TIME PHYSICAL ACTIVITY IN ADULTHOOD

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1 University of Helsinki, Finland 2 National Institute of Health and Welfare, Finland 3 University of Eastern Finland, Finland 4 Indiana University, USA **Introduction:** Some evidence suggests that in adolescence improving diversified skills or participation in more than one type of activity simultaneously enhances adults' leisure-time physical activity (LTPA). The aim of this study is to explore whether the diversity of sports in adolescence predicts the level of LTPA in adulthood. **Material & Methods:** This study comprised 3363 Finnish twins born in 1975-77 and surveyed in the FinnTwin16 Study. Baseline questionnaire took place when twins aged 16 and follow-ups of interest at the age of 17 and on average 35 years. Exclusion criteria considered participants having a disability or an illness preventing normal physical activity participation. Health behavior questionnaire at age of 17 provided information about adolescents' leisure-time physical activities with a multiple choice question of 18 different sports and an open question. We formed four categories based on the amount of participated sports: 1, 2, 3-4, and 5+. We also divided activities based on their type into four groups for qualitative analysis as follows: endurance, power, games and others. LTPA in adulthood was calculated as Metabolic Equivalent of Time (ltMET) (h/day) including active commuting. Due to skewed distribution of ltMET we used statistical method to divide participants into four activity classes for the analysis. We controlled the clustering of correlated observations from twin pairs when computing standard errors for the coefficients using robust estimators of variance in the regression models. We conducted models separately for men ( $N=1324$ ) and women ( $N=1828$ ) with adjustment for multiple confounders. **Results:** Association between the amount of participated sports in adolescence and ltMET in adulthood had no significance in men. Participation in several physical activities simultaneously, however, significantly predicted placement in a more active class in adulthood in women. Odds ratios (OR) for being in the most active versus the least active class having 2, 3-4, and 5+ participated sport activities in adolescence, compared to one activity only, were respectively:  $OR=1.62$  ( $p=0.050$ ),  $OR=1.90$  ( $p=0.024$ ), and  $OR=3.29$  ( $p<0.001$ ), based on a multinomial regression model. Mean ltMET was 4.25 h/day for men and 3.86 h/day for women whereas with participants simultaneously active in all groups (endurance, power, games, and others) or in the first three it was 5.18 and 4.88, or 5.17 and 4.89, respectively. **Discussion:** The results show that diversity of leisure-time sport activities in adolescence predicts greater leisure-time physical activity in adulthood in women, but not in men. In addition to quantity of physical activities, also quality of those activities may be relevant. Contact: sara.makela@helsinki.fi



### THE SEASONAL-RELATED VARIATION ON PHYSICAL FITNESS IN AGED POPULATION

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Introduction Studies in aging have considered either exercise type or time lasting from pre to post testing. Despite having training and timing control, these studies have not investigated the season variation impact. Whether autumn/winter environmental conditions have negative impact on health promotion in aged population it is not well established. Therefore, the aim of the study was to examine the autumn/winter environmental conditions effects on physical fitness level, in both trained and non-trained aged population. Methods 456 volunteers (age, 79±6y; height, 1.54±0.08m; weight, 69.6±12.9Kg), male (N = 130) and female (N = 326), were divided in four groups – Exercise (EG), non-Exercise (nEG), Winter exercising (WG) and summer exercising (SG). Participants were assessed three times – October/November, as baseline, April/May, after winter season, and October/November, after summer season and as one year later. Both handgrip and isometric knee extension tests were used to assess muscle strength, while 6 minutes walking test was used to assess cardiorespiratory capacity. GLM two factor, time, group and time\*group was performed to investigate differences between groups and within group, over the time. Significant differences was set at  $p < 0.05$ . Results Significant differences between groups were found over the time ( $F=27.75$ ,  $p<0.001$ ). Post-hoc analysis with Bonferroni adjustment indicated that 1) EG showed higher scores in both muscle strength and cardiorespiratory capacity than other groups, over the time ( $p<0.05$ ); 2) both SG and WG were significantly higher than nEG no cardiorespiratory capacity ( $p < 0.05$ ) but not on muscle strength; 3) SG did not show significant differences from WG, on both muscle strength and cardiorespiratory capacity. Also, no significant changes within group were found over the time. Discussion Regular exercising improves physical capacities. Seasonal exercising, winter or summer season, seems not influence differently the individual physical capacity. However, it was found a trend showing that better scores on those who exercising on winter in comparison with summer group. The findings also emphasize that more than muscle strength, on upper and lower limb, the cardiorespiratory capacity may have important improvement even when individual exercises seasonally.

### EFFECTS OF CIRCUIT TRAINING ON PHYSICAL PERFORMANCE, BODY COMPOSITION FOR THE FRAIL ELDERLY LIVING IN A RESIDENTIAL CARE FACILITY

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Introduction: A combination of aerobic exercise, strength training, balance/posture and flexibility training is recommended to optimize health and delay frailty. This study aimed to compare the dose-response effects of 12-wk "circuit exercise" and "chair-based exercise" with "usual care group" on physical performance and body composition for the elders who lived in a residential care facility and were classified as frail or pre-frail based on Fried criteria. Methods: This study was a two-staged study design; a mass frailty screening using the Fried frailty criteria was conducted in the Taipei Municipal Haoran Senior Citizens Home prior to the subsequent quasi-experimental exercise intervention trial. Physical performance and body composition were repeatedly measured before and after the intervention. Results: Two-hundred and twelve subjects participated in the first-staged frailty screening battery. In total, 20.8 % of the subjects were classified as frail, 67.0 % were pre-frail. Sixty-nine subjects enrolling in the subsequent exercise intervention trial were allocated into circuit training group (N=23, mean age: 77.0±8.8 years), chair-based exercise group (N=23, mean age: 81.1±9.8 years) and control group (N=23, mean age: 81.9±7.6 years). After 12-wk exercise intervention, the circuit training group demonstrated significant improvements on physical functions including functional reach test ( $P=.016$ ), grip strength ( $P<.001$ ), knee extensor strength ( $P<.001$ ); upper limb ( $P<.001$ ) and lower limb muscle endurance ( $P<.001$ ), 6-minute walking distance ( $P<.001$ ), as well as 5-m walking time ( $P=.008$ ). The lighter chair-based exercise group mostly kept their baseline physical performance level. In contrast, the control group revealed significant decline on grip strength ( $P=.016$ ), upper limb muscles endurance ( $P=.029$ ) and 6-min walking distance ( $P=.022$ ). There were significant between-group differences in changes from pre-test to post-test based on the group×time interaction effects ( $P<.05$ ). Regarding body compositions, the circuit training group mostly kept their limb muscle mass while both chair-based and usual care group demonstrated significant loss of muscle mass ( $P<.05$ ). Conclusions: After 12-wk exercise intervention, the more intensive circuit training group showed significant improvements on most measures of physical performance and physical fitness along with keeping their baseline muscle volume. The lighter chair-based exercise group tended to maintain their baseline physical performance level but decreased muscle mass somewhat. The usual care group declined significantly on physical performance, fitness and muscle mass simultaneously. There was obviously a dose-response effect of exercise training for the frail or pre-frail elderly. Reference: Chen X, Mao G, Leng SX. (2014): *Clin Interv Aging*, 19, 433-41. Berrut G, Andrieu S et al. (2013): *J Nutr Health Aging*, 17(8), 688-93. Cesari M, Vellas B et al. (2014): *J Gerontol A Biol Sci Med Sci*, 70(2), 216-22

### EFFECTS OF 12 WEEKS OF MULTI-COMPONENT VS. WBV TRAINING ON STRENGTH IN POSTMENOPAUSAL WOMEN

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INTRODUCTION The increment of muscular strength of lower limbs decreases the likelihood of a fall, sprain or fracture (Fox et al., 2008; Pizzigalli et al., 2011). Whole body vibration (WBV) and multi-component training (MT) are effective ways to avoid loss of strength. Therefore, the aims of the present study were to analyze the effects of two different training protocols (vibratory platform and multi-component training) and to determine what kind of training creates greater adaptations on the isokinetic strength of the stabilizer muscles of the ankle joint in postmenopausal women. METHODS Thirty-eight women (59.8 ± 6.2 years) were randomly assigned to whole body vibration group (WBVG), multi-component training group (MTG), or a control group (CG). The experimental groups performed an incremental training for 12 weeks, 3sessions/week. The subjects in WBVG remained on the platform in a static semi-squat position with a hip/knee angle of 120° and performed ankle plantar flexion every 6 times (100bpm). Participants in MTG combined aerobic exercise with drop jumps. Isokinetic peak torque of ankle joint for eversion and inversion (60°•s-1 and 120°•s-1) was assessed. RESULTS In the training groups was found a significant increase for eversion at 60°•s-1 (WBVG:  $p = 0.001$ ; and MTG:  $p = 0.003$ ), inversion at 60°•s-1 (WBVG:  $p = 0.015$ ; and MTG:  $p = 0.044$ ) and eversion at 120°•s-1 only in the WBVG ( $p = 0.012$ ) from pre-test to post-test. There were no significant differences between WBVG and MTG in ankle strength tests. Significant changes were not observed in CG in any of the strength measurements. DISCUSSION The instability that adopts the ankle to make the dynamic pattern on the vibratory platform and the dorsiflexion position for cushion the impact during the landing in MT, could justify the improvement on the strength of the ankle evertors and invertors. Furthermore, the passive activation of the ankle stabilizers is necessary during the drop jump to the imbalance occurs (McCaw and Cerullo,

1999). In this sense, these results are considered very important, as the falls are a major cause of morbidity and mortality in actual society, especially in postmenopausal women. The training programs produced significant adaptations on strength. However, the improvements were similar for both groups and we cannot claim that WBVG is better than MTG, or viceversa. REFERENCES Fox J, Docherty CL, Schrader J, Applegate T. (2008). *J Athl Train*, 43, 51-54. McCaw ST, Cerullo, JF. (1999). *Med Sci Sports Exerc*, 31, 702-707. Pizzigalli L, Filippini A, Ahmaidi S, Jullien H, Rainoldi A. (2011). *J Strength Cond Res*, 25, 567-574.

### **FACILITATING DAILY PHYSICAL ACTIVITY, COGNITIVE EXECUTIVE FUNCTION, AND MENTAL HEALTH AMONG ELDERLY PEOPLE: A ONE-YEAR INTERVENTION**

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**Introduction** It has been reported that daily physical activity (PA), plays an important role in maintaining psychological health of the elderly. However, it is not clear exactly what intensity and amount of daily PA are most effective in guarding against psychological decline. The present study conducted a 1-year intervention study to reveal the effects of daily PA on psychological wellbeing, with a focus on cognitive executive function and mental health. **Method** More than 120 people aged 65 or over participated in this study. They wore an electronic accelerometer throughout their waking hours for a year to assess the amount and intensity of their individual daily PA. The accelerometer recorded the number of steps they walked and the duration of PA per day as either Low (<3Mets) or Moderate (≥3Mets) activity. Participants randomly divided into three groups: Low active (LA), Moderate active (MA), and Control (Co) groups. The LA group was instructed to spend more time walking daily than they had done previously before the study. The MA group was instructed to increase their amount of time engaging in moderate PA. The cognitive executive function was tested by using a task-switching test. Mental health was examined with the questionnaire SF-36. These outcomes were measured at two periods of baseline and one-year follow-up. **Result** The time (minutes) spent per day at both Low and Moderate PA levels was averaged over quarterly time periods throughout 1-year in order to take into account seasonal deference of daily PA. 2-way ANOVA (Season vs. Group) showed that fluctuations in the amount of PA based on seasonality were highly-correlated between all 3 groups. Psychological results were tested using 2-way ANOVA (Time vs. Group) and showed that significant interactions between factors were non-existent. Additional analysis was conducted by further dividing participants into two groups: the first being the MA+ plus group consisting of participants who increased their moderate PA time throughout 1-year, the other being the MA- minus group made up of participants who decreased their moderate PA during the 1-year period. The results showed that task-switching performance was significantly improved among the MA+ group compared with the MA- group. In addition, the SF-36 scores of Physical functioning, Role physical, and Role emotion were significantly improved within the MA+ group compared with the MA- group. **Discussion** The present study demonstrated that over the course of a year this exercise intervention partially contributed to a small community of elderly people increasing the amount of time spent engaged in moderate PA. Moreover, we realized that increasing the amount of moderate PA over 1 year improved the executive cognitive function and QOL. Contact:kimura@cck.dendai.ac.jp

### **THE EFFECTS OF RESISTANCE, AEROBIC AND COMBINED TRAINING AND DETRAINING ON MUSCLE STRENGTH IN CORONARY ARTERY DISEASED PATIENTS**

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**Introduction** Every year an increasing number of individuals are diagnosed suffering from coronary artery disease (CAD). For combating CAD exercise training and the avoidance of sedentary life style is recommended (Tully et al., 2005; Booth et al., 2012), in order to avoid skeletal muscle atrophy and impaired muscle strength. The purpose of the present investigation was to compare the effects of three types of chronic exercise on muscle performance in aged patients suffering from CAD. **Methods** Fifty-six elderly diagnosed with CAD participated in the study and allocated in the aerobic exercise (n=15), the resistance exercise (n=11), the combined exercise (n=15) and the control (n=15) groups. The three exercise groups carried out 8 months of aerobic, resistance or combined training. Before, at 4th and at 8th month of the training period as well as at 1st, 2nd and 3rd month after the training cessation, muscle knee extensors peak torque was measured. **Results** By the 4th and 8th month of training, muscle strength was increased in all groups compared to baseline. More specifically, after 8 months of aerobic, resistance or combined exercise peak torque of knee extensors was increased by 13.8%, 41.1% and 26.5%, respectively, while peak torque of knee flexors was increased by 7.7%, 40.3% and 24.8%, respectively. At 8th month of training, peak torque was significantly higher in resistance and combined exercise groups compared to the aerobic exercise and the control group. At the 3rd month of the detraining period, peak torque of knee extensors and flexors in the resistance group (19.5% and 14.5% respectively) and the combined group (16.0% and 12.5% respectively) was still significantly higher compared to the baseline values. **Discussion** To our knowledge, this is the first "year round" intervention that investigated the effects of chronic aerobic, resistance and combined exercise training and detraining on muscle strength in elderly individuals with CAD. It was found that muscle strength has been increased mainly by resistance and combined chronic exercises, with the former to cause the greatest alterations as it was expected. Resistance and combined training seems to counterbalance the impaired muscle strength in elderly which is associated with an increased risk of functional impairments that may lead to decreased independence and mobility. **References** Tully MA., Cupples ME., Chan WS., McGlade K., Young IS. (2005) *Preventive medicine* 41 (2):622-628. Booth FW., Roberts CK., Laye MJ. (2012). *Comp. Physiol.* 2, 1143-1211.

### **PARTICIPATION OF SENIORS IN LONG-DISTANCE RUNNING RACES IN POLAND AND SWEDEN.**

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**Introduction** Recreational running, as a form of physical activity, has gained popularity in Poland since lifting the amateur runner license in early 90's. Over the last several years, according to annual data of the Polish Running Association, we have observed a significant increase in the number of participants in organized running events (Pascal, 2014) in Poland. The purpose of the study was to examine the participation of senior runner (60+ yrs) in half marathon and marathon races between 2011 - 2014 in Poland and Sweden. **Methods** The study was conducted based on the officially announced results of the most popular running events in Poland and Sweden. Six half marathons and six marathons were studied, three from each in each country. **Monographic method** was used, document analysis techniques

and statistical analysis to examine the changes in the proportion of senior runners in these races between 2011 - 2014. A comparison of these changes between both countries was made. Results There were no significant differences in participation between the percentage of senior runners from Poland in Poznan Marathon (3,09%) and Swedish runners in ASICS Stockholm Marathon (2,66%) in those years. Discussion Despite expected perceived difference in health awareness and health care in Poland and Sweden no difference was found in the proportion of seniors participating in half marathon and marathons. Liquidation of Polish amateur runner license by Athletics Association has increased the popularity of recreational races at half marathon and to a lesser extent in marathons. These changes indicate appreciation of physical activity as a determinant of health, which results in increased health awareness of runners in Poland in comparison with the number of runners in Sweden. References H. Paskal, Statistics of road races in Poland 2011–2014, Annual Conf. of Polish Road Races Assoc., November 20–22, 2014, Zielona Gora (Poland), M. Silverstein, M. G. Parker, Leisure Activities and Quality of Life among the Oldest Old in Sweden, Research on aging vol. 24, no. 5, 528-547. Contact czajkka@gmail.com

#### **APPLICABILITY OF ULTRASOUND MUSCLE THICKNESS MEASUREMENTS FOR PREDICTING QUADRICEPS FEMORIS MUSCLE VOLUME IN MIDDLE-AGED AND ELDERLY POPULATION.**

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1: National Institute of Fitness and Sports in Kanoya, 2: Shibaura Institute of Technology, 3: Doshisha University, 4: Chiba University, 5: Chukyo University, 6: Waseda University.

**Introduction** Age-related decline in the muscle volume of quadriceps femoris (QFMV) attenuates the activities of daily living in elderly (Fujita et al. 2011). In order to assess physical working capacity in elderly from the viewpoint of physical resource, therefore, it is essential to develop method which can accurately estimate QFMV in elderly. In an earlier study using young adult men (Miyatani et al. 2004), it was shown that ultrasound muscle thickness (MT) measurement at the mid-thigh is useful to predict QFMV. For elderly population of both sexes, however, whether the MT at the mid-thigh can be applicable to predict QFMV is unknown. The purpose of this study is to examine the applicability of MT at the mid-thigh for predicting QFMV in middle-aged and older individuals. **Methods** A total of 60 Japanese subjects (51 to 77 yr, 30 males and 30 females) participated in this study. QFMV were determined by magnetic resonance imaging (MRI-QFMV). MT at anterior mid-thigh was measured with a brightness-mode ultrasound. A stepwise multiple regression analysis was used to produce a prediction equation of MRI-QFMV with MT, sex (male = 1, female = 0), thigh length as independent variables. In addition to the examination of the difference between MRI- and estimated QFMV values, systematic error was confirmed by the Bland-Altman plot. **Results & Discussion** The regression analysis produced a prediction equation:  $\text{MRI-QFMV (cm}^3\text{)} = (\text{sex} \times 251.539) + [\text{MT (cm)} \times 233.377] + [\text{thigh length (cm)} \times 47.256] - 1817.430$ . The R<sup>2</sup> and the standard error of estimate (SEE) of the developed equations were 0.896 and 119.2 cm<sup>3</sup> (11.7%), respectively. There was no significant difference between the MRI- and estimated QFMV values, without a significant systematic error. The observed SEE value was similar to those reported in earlier studies using young population (11.1-11.9%, Miyatani et al. 2002, 2004). These results suggest that the prediction equation with MT at the mid-thigh, sex, and thigh length is useful to estimate QFMV in middle-aged and elderly population. **Conclusion** Ultrasound MT measurement at the mid-thigh is applicable to predict QFMV in middle-aged and elderly population. **References** Fujita et al. (2011) Med Sci Sports Exerc 43 (12): 2328-2334. Miyatani et al. (2002) Eur J Appl Physiol 86 (3): 203-208. Miyatani et al. (2004) Eur J Appl Physiol 91 (2-3): 264-272. Contact Nakatani Miyuki [m136014@sky.nifs-k.ac.jp]

#### **COMPARISON OF POLAR LOOP AND ACTIGRAPH ACTIVITY MONITORS IN DETECTING PHYSICAL ACTIVITY AND SEDENTARY TIME IN DAILY LIVING AMONG ADULTS**

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1: University of Jyväskylä (Jyväskylä, Finland), 2: LIKES – Research Center for Sport and Health Sciences (Jyväskylä, Finland), 3: Polar Electro (Kempele, Finland).

**INTRODUCTION** Daily physical activity (PA) and sedentary time (ST) have diverse influence on health. Accelerometry has been proposed as a method to objectively quantify time spent sedentary in addition to generally used measures of PA. Reliability and validity of the measurement as well as feasibility of the device are essential to draw the conclusion of PA and ST. The purpose of this study was to compare wrist worn Polar Loop (Loop) and hip worn Actigraph (AG) activity monitors. **METHODS** Eighteen voluntary executives (9 females and 9 males, aged 48±10 yrs.) wore simultaneously tri-axial Loop and AG for 8-10 days in free living conditions. Troiano (1) and Freedson (2) cut-off points were used for AG and personally set cut-off points for Loop for dividing PA into four categories; sedentary time (ST), and light, moderate and vigorous PA. Furthermore moderate to vigorous PA (MVPA) was calculated and total daily PA was calculated as a sum of light PA and MVPA. Data was analysed tracking each data collecting day as a single case. **RESULTS** Totally 175 days were monitored and the average simultaneous wearing time was 14:45 h:min/day. Daily sedentary time was 71%, and time spent in light, moderate and vigorous PA was 23%, 6%, and 1%, respectively. Correlations between Loop and AG monitors were 0.95 for ST, 0.86 for light PA, 0.74 for moderate PA, 0.25 for vigorous PA, 0.83 for MVPA and 0.89 for total daily PA (all p-values < 0.001). Mean differences between Loop and AG were: ST 31±47 min, light PA -41±44 min, moderate PA 8±27 min, MVPA 10±25 min, total daily PA -31±47 min (all p-values < 0.001) and vigorous PA 2±18 min (p=n.s.). Bland & Altman analysis (3) showed that there was no significant correlation between the mean value and the difference between Loop and AG in ST, moderate PA, MVPA and total daily PA. A significant correlation was found only in light PA (r=0.15, p<0.05) and vigorous PA (r=0.18, p<0.05) while using Troiano cut-off points, but not while using Freedson cut-off points. **DISCUSSION** These findings indicate that both Polar Loop and Actigraph measured and categorized total daily PA, ST, moderate PA and MVPA equally. Depending on used cut-off points, differences were seen only in light and vigorous PA. However, vigorous activity has minor role in daily life and in general, cut-off points play an important role when comparing PA results and different PA categories. In conclusion, both studied accelerometers can be used in measuring daily PA equally. **REFERENCES** 1) Troiano RP et al. MSSE 40(1), 2008. 2) Freedson PS et al. MSSE 30(5), 1998. 3) Bland & Altman DG. Lancet 1, 1986. e-mail: minna.m.tanskanen@ju.fi

## Mini-Orals

### MO-BN06 Coaching: Mixed session

#### A STUDY ON NATIONAL QUALIFICATION TRAINING PROGRAMS FOR SPORTS INSTRUCTOR IN SOUTH KOREA

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The purpose of this study was to investigate the current state of and problems with the qualification training programs in south korea, which make up the final process in the qualification examination newly reorganized in 2015. Researcher conducted a literature study, collected the standard qualification training programs documents of 2015, and analyzed by content analysis. The qualification system of sports instructor includes a national qualification for professional sports instructors, sports for all instructors, health and exercise managers, sports instructors for the disabled, sports instructors for youth, and sports instructors for the elderly. Each of the qualification examinations qualification training programs to those who have passed the theory and practice tests. A certificate is issued to those who have completed qualification training courses. Qualification training programs is the core process in the qualification system. Qualification training programs have different aspects according to the qualification types and are comprised of sports ethics, sports, health and safety management, instruction capabilities, sports management, and field practice. The newly qualification training programs have such problems as content that is not fit for the qualification types, absence of leader qualities and roles, and absence of field practice content. Based on those findings, the study proposed that there should be program diversification and differentiation, reinforcement of leader qualities, and systematic field practice.

#### TRAINING RELATED TO ALTERATIONS: POSTURAL ANALYSIS AND BIOMECHANICS OF GAIT IN BALLET

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**Introduction** The dominant element in ballet is the search for flawless performance. Requiring specific training from early years, this may cause some changes compared to the normal human anatomy and physiology, particularly to the spine and lower limbs (Green Haas, 2013). The object of this study concerns the assessment of the fundamental gesture of this discipline: the en dehors. The biomechanical evaluation of en dehors, and more specifically the nature of postural compensation employed by the dancer in the search for an optimal execution, appears to be of fundamental importance in understanding the changes that can occur due to a teaching that does not take into account the morphofunctional characteristics of the subject (Howse & McCormack, 2009). **Methods** The initial phase of the research included a postural test carried out on a sample of ten dancers, chosen according to their professional level, with the aims of assessing posture in a static condition and identifying possible alterations and compensations generated. Two types of data were collected: in a natural position to highlight possible alterations of the main body segments involved in the technical implementation of en dehors and in an en dehors position to verify the eventual accentuation of the same alterations and to confirm, therefore, how these can be a result of the practice of this technical position. For the collection of data, the system Bts Smart D for integrated multifactor analysis of human movement and the Davis clinical protocol for gait analysis were used (Davis, 1991). **Results** The study revealed some postural alterations in the dancers both in a natural position and during normal ambulation. The biomechanical gait analysis in en dehors showed substantial changes compared to normal walking. Compensations have also been identified, which may be linked to training. **Discussion** Considering the sample size and the absence of a control group, this research can be considered a pilot study. The critical aspects which emerged from this research indicate the need of an approach to teaching that would enable the coach to plan the training consciously and adequately, in relation to the morphofunctional characteristics of the dancer. **In conclusion**, the scientific comparison among experts and those working in the field of motor performance can make an important contribution to prevent morphofunctional alterations and generally to promote the health of those who ballet at professional levels. **References** - Davis, R. B., Ounpuu, S., Tyburski, D., & Gage, J. R. (1991). A gait analysis data collection and reduction technique. *Human Movement Science*, 10(5); - Green Haas J., (2013). *Dance Anatomy*. Calzetti & Mariucci Editori; - Howse, J., & McCormack, M. (2009). *Anatomy, Dance Technique and Injury Prevention* A&C Black.

#### WHAT IS HUMANISTIC LITERACY FOR COACHES?

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The aim of this study is to clarify the meaning of coach humanities literacy and its educational implications. The humanistic literacy for coach, a concept unifying humanities and literacy, means the literacy in the humanities. Specifically, it means the ability to read and write humanistic texts by coaches. Humanistic literacy pursues critical thinking and experience as free men, the telos of humanities. At the same time, it involves all efforts being done by educators to develop students' literacy for humanistic texts in order to make them critical and free thinkers. For higher education, humanistic literacy for a coach has educational implications. First of all, it lets us understand the roles of coach humanistic education as an initiation into the traditional practices. Second, it restates reading and writing in coach education, which are sometimes dealt with individually, in terms of concrete activities, through which it makes possible the meaningful cycle of reading and writing. Moreover, it helps achieve one of the goals of coach education, developing basic ability to gain an insight into life through a humanistic perspective. Third, it can be used as a guide for structuring educational experiences, helping educators and pre-coaches clearly understand educational goals and activities.

#### PASSIVE DRAG IN YOUNG SWIMMERS

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**INTRODUCTION** Passive Drag is very important factor to obtain a high performance in swimming sprint events. The focus of this paper is evaluate  $k$  (as hydrodynamic coefficient) about swimmers who present similar passive drag and assess any improvements linked to the reduction of  $k$  (Chatard et al., 1990). Some factors that influence  $k$ , refer to body position in the water, buoyancy and swimmer's anthropometric characteristics. System modeling of  $k$  is not particularly complex because the swimmer is not engaged in advancing and his

hydrodynamic set-up is constant. However setting a precise attitude, improvements to performance are generated by dissipation of the same swimmer. The improvements of glide capacity can be used for a good performance in swim sprint events. METHODS Eight national male swimmers who are specialists into 50 m freestyle (age  $15.0 \pm 0.00$  years; height  $178.6 \pm 3.70$  cm; weight  $66.4 \pm 3.90$  kg) participated in the study. The swimmer in hydrodynamic position will wear a belt around the waist which will be connected to the Speed R. Between the hands holding the end part of the elastic previously characterized, which has been fixed to the opposite side of the pool. The swimmer without going off the wall will leave to bring forth from the strap, simultaneously the Speed RT acquires data in real time that will be then processed with a special software (Bixler et al., 2007). The exercises to improve hydrodynamic coefficient were: glide phases in different depth (4x8 rip), awareness of glide position with the head low, medium and high (4x8 rip), ranges floating to vary buoyancy and hydrodynamic position (4x8 rip). Swimmer dedicated 20 minutes extra to training to perform specific exercises with a frequency of four times a week. After three months training used to improve the hydrodynamic profile and thus the decrease of k we repeated the measurements to assess whether hydrodynamic qualities improvements produced performance improvements. Data analysis was performed with the Student's t-test, whose significance was placed at  $p < 0.05$ . RESULTS Hydrodynamic coefficient (k) passed from pre-training ( $38.8 \pm 0.70$ ) to post-training ( $38.6 \pm 0.72$ ), with  $p=0.00$ . Training improved the time of 50 m, that passed from ( $24.42 \pm 0.33$  s) to ( $24.35$  to  $\pm 0.00.34$  s) with a statistical significance of  $p=0.00$ . Performing a good glide phases, achieved with a special training, is useful for a sprint swimmer to go faster. DISCUSSION Improving hydrodynamic coefficient can bring benefit to performance. Spending part of the training to improve hydrodynamic position during start and turn phases could be decisive in sprint events. REFERENCES Bixler B, Pease D, Fairhurst F. (2007) Sports Biom, 6, 81-98. Chatard JC, Lavoie JM, Bourgoin B, Lacour JR. (1990) Int J Sports Med 5,367-72. CONTACT claudio.ciapparelli@tin.it

### EFFECT OF HAND PADDLES ON INTRA-ABDOMINAL PRESSURE DURING MAXIMAL FRONT CRAWL SWIMMING

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Introduction Intra-abdominal pressure (IAP) increases with swimming velocity within subjects (Moriyama et al., 2014c). When maximal swimming velocity ( $V_{max}$ ) is compared, paddle-aided swimming (P) is generally higher than normal swimming (H). Therefore, we hypothesized that IAP during maximal P is higher than that during maximal H, and compared IAP between two conditions. Methods Nine highly trained competitive collegiate female swimmers ( $1.61 \pm 0.03$  m,  $52.1 \pm 4.3$  kg) participated as subjects in this study. Experiments were carried out in a competitive swimming pool. Subjects performed front crawl swimming with or without hand paddles with maximal effort. IAP was taken as the difference between minimum and maximum values using the mean of 4 stable front crawl stroke cycles. Stroke rate (SR) and length (SL) served as stroke indices. Results  $V_{max}$  (H ;  $1.50 \pm 0.03$  m · s<sup>-1</sup>, P ;  $1.53 \pm 0.02$  m · s<sup>-1</sup>) and SL (H ;  $1.62 \pm 0.10$  m, P ;  $1.72 \pm 0.12$  m) were significantly higher in the P than in the H ( $P < 0.05$ ). The SR (H ;  $0.93 \pm 0.06$  Hz, P ;  $0.89 \pm 0.06$  Hz) was significantly higher in the H than in the P ( $P < 0.05$ ) whereas no significant difference was observed in IAP (H ;  $1.7 \pm 0.5$  kPa, P ;  $1.6 \pm 0.3$  kPa). Discussion Using hand paddles, swimmers could swim faster than not using them. However, no significant difference was observed in IAP between P and H, and our hypothesis was not verified. Additionally, we have reported that IAP at maximal swimming velocity does not differ between skilled and unskilled swimmers (Moriyama et al. 2014a,b). Further, swimming technique is more important factor to swim faster than the ability to generate metabolic power. (Ogita et al. 2006). In conclusion, it is revealed that increased swimming velocity with hand paddles elicits no significant increase in IAP. References Moriyama S, Kanazawa S, Yamagata K, Kitagawa Y, Ogita F. (2014a). BMS2014 handbook, 139-140. Moriyama S, Kanazawa S, Yamagata K, Kitagawa Y, Ogita F, Takahashi H, Hirano Y. (2014b). J Exerc Sports Physiol, 21(1), 9-15 (in Japanese). Moriyama S, Ogita F, Huang Z, Kurobe K, Nagira A, Tanaka T, Takahashi H, Hirano Y. (2014c). Int J Sports Med, 35(2), 159-63. Ogita F, Tanaka T, Tamaki H, Wagatsuma A, Hamaoka T, Toussaint HM. (2006). Portuguese J Sports Sci, 6 (Supl.2), 194-197. Contact moriyama@jwpcpe.ac.jp

### BASKETBALL GAMES LOAD MEASUREMENT USING COMMERCIAL ACCELEROMETRY

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Introduction The Adidas miCoach is a commercial accelerometer presenting accuracy levels and proper design to quantify physiological loads in professional team sports like basketball (Porta et al., 2012). Some research has been conducted in the past to determine the physiological demands of basketball (Ben Abdelkrim et al., 2007), their differences according to game positions (Sallet et al.; 2005) and the effects of fatigue throughout the games (Leite et al., 2013). The present study uses this technology to provide additional data about top-level basketball players. Methods During 125 Spanish Division I matches two players from the same team, selected at random, wore a miCoach Speed\_CellTM sensor attached to the right shoelaces during the entire game. Data inclusion criteria considered players with at least 5 active minutes per half (excluding warm-up exercises). Players were divided into three groups according to their playing position (46 centers, 34 forwards, 44 guards). The Speed\_CellTM provided the amount of high-intensity efforts/active minute ratio (HIER), distance covered in high-intensity efforts/active minute ratio (HIERm) and the overall distance/ active time ratio (DAT). We compared these variables between first and second halves of the game and among different game roles. Results Players perform more HIER, HIERm and DAT during the first half when compared to the second ( $p < .001$ ). Comparison between roles only showed significant differences in HIERm favoring forwards when compared to centers. Discussion In a previous study using accelerometry forwards were revealed as the players with higher physical demands within the game (Moreno et al., 2013), differing from earlier studies where guards were pointed out as the players with higher intensity demands (Ben Abdelkrim et al., 2007). Forwards covered more meters during HIE compared to centers. When comparing halves, first half seems to involve more efforts in a consistent manner, more distance covered at a high intensities and more overall distance covered. These results agree with those presented by Leite et al. (2013) who pointed fatigue as the main factor for such a significant decrease. References Porta JP, Acosta DJ, Leher AN, Miller JT, King GA. (2012). International Journal of Exercise Science: Conference Abstract Submissions, 2(4), article 23. Ben Abdelkrim N, El Fazaa S, El Ati J. (2007). Br J Sports Med, 41, 69-75. Sallet P, Perrier D, Ferret JM, Vitelli V, Baverel G. (2005). J Sport Med Phys Fit, 45(3), 291-294. Moreno D, Peña J. (2013) Proceedings of the 18th Congress of the European College of Sports Sciences. Leite N, Coutinho D, Sampaio J. (2013) Revista de Psicología del Deporte 22(1), 215-218. Contact dani.moreno@dmtrainingpro.com

## CONTACT TECHNIQUE AND CONCUSSIONS IN THE SOUTH AFRICAN UNDER-18 COCA-COLA CRAVEN WEEK RUGBY TOURNAMENT

Hendricks, S., O'Connor, S., Brown, J., Burger, N., McFie, S., Readhead, C., Viljoen, W., Lambert, M.  
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**Introduction** In rugby, understanding the techniques and events leading to concussions are important because of the nature of the injury, and the severity and potential long-term consequences, particularly in junior players. Proper contact technique is a prerequisite for successful participation in rugby and is a major factor associated with injury. However, the execution of proper contact technique and its relationship to injury has yet to be studied in matches. Therefore, the aim of this study is to compare contact techniques leading to concussion with a representative sample of similarly matched non-injury contact events. **Methods** Injury surveillance was conducted at the 2011-2013 under-18 Craven Week Rugby tournaments. Video footage of 10 concussive events (5 tackle, 4 ruck and 1 aerial collision) and 83 non-injury events were identified (19 tackle, 61 ruck, 3 aerial collisions). Thereafter, each phase of play was analysed using standardised technical proficiency criteria. The Student t-test and effect sizes were used to compare scores for each technical criterion on the list, and overall for ruck, tackler, ball-carrier, and aerial contact proficiency. Statistical significance was set at  $p < 0.05$ . **Results** Overall score for ruck proficiency in concussive events was 5.67 (out of a total of 15) versus 6.98 for non-injury events ( $n=54$ ) ( $p > 0.05$ , effect size=0.52, moderate). Overall average score for tackler proficiency was 7.25 ( $n=4$ ) and 6.67 ( $n=15$ ) for injury and non-injury tackles, respectively (out of 16) ( $p > 0.05$ , effect size=0.19, small). **Conclusion** This is the first study to compare concussion injury contact technique to a player matched sample of non-injury contact techniques. Certain individual technical criteria had an effect towards a non-injury outcome, and others had an effect towards a concussive event, highlighting that failure to execute certain techniques may substantially increase the opportunity for concussion. Contact Sharief.hendricks01@gmail.com Twitter: @Sharief\_H

## FROM MILITARY NORMS TO INDIVIDUAL COACHING: A CHANGING EDUCATIONAL DISCOURSE AS AN ANSWER TO COMMERCIAL CHALLENGES IN SWEDISH RIDING SCHOOLS

Thorell, G., Morgan, K., Hedenborg, S.

*The Swedish national Equestrian centre at Strömsholm*

**Introduction** Research show that the Swedish stable environment is characterized by a military discourse even though equestrian sport has passed through a paradigm shift concerning gender (Forsberg&Tebelius, 2011; Hedenborg, 2009; Thorell&Hedenborg, forthcoming). There is, however, a lack of previous research on teaching and leadership in riding schools. It seems that the historical, military, educational stable culture signified by respect and discipline is challenged today by the expectations of society. The aim of this study was to identify critical issues in the profession of a riding instructor concerning this shift in relation to youngsters' view of the riding school. **Method** The source material consists of written documents, interviews with riding instructors and focus group interviews with young people. A constructivist grounded theory method have been use to collect and analyze the data. The theoretical frame originated in a sociocultural perspective on learning and situated learning (Lave & Wengers 1991). **Results** Interviewed riding instructors point out that there has been a change the last decade. Development of the society and economic factors has moved the instructors to change to a educational model built on a sensitive and humble approach to make their pupils stay at the riding school. The youngsters' reasons for spending time at the riding school were feelings of affinity, comradeship and to be part in an organisation with horses. **Discussion** An increased commercialisation of all sports for youngsters has moved the riding schools towards an adaption to the market. The interviewed riding instructors' points to that teaching today are characterised by an individualisation and coaching. This coincides with what the interviewed youngster valued. The riding instructors can develop their teaching through a broader pedagogical and didactical perspective. A more coaching and reflective approach is seemingly needed in order to reach the youngsters and generate a life-long interest. The outcomes of this project are useful for riding instructors and trainers in the horse business, it is also important to discuss the pedagogical content in the education of future riding instructors. **References** Forsberg L. & Tebelius U. (2011). The riding school as a site for gender identity construction among Swedish teenage girls. *World Leisure Journal*. 53:1, pp 42-56. Hedenborg, Susanna. (2009). Till vad fostrar ridsporten? *Educare* 2009:1, s.61-78. Lave, J. & Wenger, E. (1991). *Situated Learning. Legitimate peripheral participation*. Cambridge University Press. Thorell G. & Hedenborg S. forthcoming. Contact: gabriella.thorell@stromsholm.com

## GOLF - PATHWAYS AND SCORES, CLUBS AND HOLES

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**Introduction:** Various Golf Courts offer to Players several holes' challenges which imply different technical behaviors and game characteristics, allowing each player to select the more adequate club to his physical and technical performance. In order to evaluate performance related to this club selection, an analysis of most used clubs is made and pattern of clubs' selected was verified. **Objective:** Analysis of the score of each player, relation with handicap, Hole Pair, Golf Court and Clubs used, as well as evaluation of Hole' difficulty degree related to Pair. **Methodology:** This quantitative, exploratory and transversal study, was configured by data provided from Scorecards. Sample intentionally comprised 38 golfers with Handicap properly approved and presenting age average 41,13 years and a standard deviation 8,4. Used SPSS20 ( $p \leq 0, 05$ ). Data processing was made by descriptive analyzes, TTest, Factorial Analyzes to define Strong-lines of the interviews, and finally ANOVA was made to test average parity corresponding to each IMC level. **Results:** Verified that Vidago Golf Course is constituted by 10-"Pair4", 4-"Pair3" and 4-"Pair5". Also confirmed that the obtained score varies between one shot below the Pair, or the same number of shots and the Pair. The most used clubs are Drive and Putter. Amarante's Golf Course has 8-"Pair4", 7-"Pair3" and 3-"Pair5". Verified that there are significant differences between scores referents to Holes "Pair5". Most used clubs are Drive and Putter. Fôjo Golf Course is composed by 12-"Pair3" and 6-"Pair4". Calculated that there are significant differences between the scores referent to holes "Pair3". Most used club is Putter. Vale Pisão Golf Course has in its course 9-"Pair4", 6-"Pair5" and 3-"Pair3". We found that there are significant differences between the scores referent to holes "Pair4" and "Pair5". Used most club is Putter. There are significant differences between scores register at different Golf Courses levels, both for holes "Pair3", "Pair4" and "Pair5" at a level of each different Pairs and between Players Scores with different handicaps. Found that most used clubs are Putter in 44% of the shots and Drive in 17,2%. Beyond these, SW and Iron7 assumed some relevance. Verified a strong connection between players' Scores and course, hole, pair and handicap, which allowed us to create a model of linear regression that predicts the player score in function of his handicap, the pair, the hole and the course where the game is going to take over. The final model estimated is given by:  $SCORE = 1,184 + 0,799 \times (PAIR) + 0,028 \times (HANDICAP) - 0,197 \times (COURSE) + 0,022 \times (HOLE)$ . **Conclusion:** The final Score in each hole is intrinsically

related with the hole pair, the player's handicap, the Golf Course and the hole in question. At the Golf Courses studied we noticed that the holes of each pair have all different difficulty levels. We also verified that there are several significant differences between the Scores reached by Professionals and Amateurs. Regarding to the clubs' frequency, we found that the most used are Drive, Putter and Iron7.

## Mini-Orals

### MO-SH02 Physical Education and Pedagogics I

#### EFFECT OF USING VISUAL INFORMATION IN SELF-CHECK STYLE ON GRAB START SKILL RETENTION, KNOWLEDGE, AND ANXIETY LEVEL.

Coşkun, H.

*Hacettepe University*

The purpose of this study was to determine the effect of using visual information in self-check style on grab start skill retention, knowledge, and anxiety level of university students. The research was done at TED Ankara Collage Sport Facility swimming pool in 2008. It was pre-mid-post test design with control group and retention test was delivered 10 days later. Sixty university students involved in the study that were randomly assigned one of the three group 20 (M=10; W=10) in each. Qualitative written examination were used to determine knowledge level. To determine the Grab Start skill level a check list were used which was prepared by experts. Spielberger State-Trait Anxiety Inventory (STAI) were used to determine the anxiety level of the students. Repeated Measure ANOVA were computed to determine the pre-mid-post test knowledge and skill acquisition level. Bonferroni Comparison Tests were applied when F value were significant. In order to determine the retention Pared Two Saple T Test were computed between post test and retention test. One Way ANOVA were computed to determine the difference between groups on knowledge and skill acquisition. Scheffe were calculated when the obtained F value were significant. The results showed that there was a significant difference among the pre-mid-post test knowledge scores of the visual feedback group (F = 78.51; p = 0.000). Mid and post test scores were similar (p = 0.874) and significantly different from pretest scores (p = 0.000) and there was a significant difference among the pre-mid-post test skill acquisition scores of the visual feedback group (F = 119.65; p = 0.000). Mid and post test scores were similar (p = 1.000) and significantly different from pretest scores (p = 0.000). Moreover, there was a significant difference among the pre-mid-post test knowledge scores of the nonvisual feedback group (F = 94.72; p = 0.000). Mid and post test scores were similar (p = 0.542) and significantly different from pretest scores (p = 0.000) and there was a significant difference among the pre-mid-post test skill acquisition scores of the nonvisual feedback group (F = 64.28; p = 0.000). Mid and post test scores were similar (p = 1.000) and significantly different from pretest scores (p = 0.000). Finally, there was statistically significantly difference between posttest and retention test knowledge scores of the nonvisual feedback group's (t = 3.06; p = 0.006). As a result, we can say that there was skill and knowledge acquisition at both group regardless of delivering visual information or not. On the other hand, the retention test was revealed that visual information were more effective at the acquisition of knowledge comparing to nonvisual information group. State and trait anxiety level of the students were high throughout the study at both groups.

#### DANCE PERFORMANCES ON SPORTS DAY IN JAPANESE SCHOOLS

Hatano, Y.

*Kobe Shinwa Women's University*

**Introduction** In the 2008 update of the Guidelines for the Course of Study provided by the Japanese Ministry of Education and Science, dance, was changed to a compulsory subject, suggesting that it has been positioned as an increasingly important subject. In this study, dance means an element of physical expression for education in a wide range of ages: officially called "expression" in kindergarten, "expression activity" in elementary school, and "dance" as an independent subject in junior high school, high school and college or university. Practical researches on teaching methods of the main areas of dance included in the Guidelines have already been extensively conducted, but there are few studies on dance on sports day, which is a big event in school. This report examines recent research trends concerning dance on sports day and its practices in Japanese school education and clarifies the future outlook for dance education in conjunction with school events such as sports day. **Methods** The JNII database was used to search research papers, academic presentation abstracts, and other written sources concerning dance on sports day. Also, teachers who taught dance on sports day were interviewed. **Results** Since the early 1990s, reports concerning dance on Sports Day have been identified in the database, but very few. Most were practical reports on dance choreographed by school teachers to seek a bridge between dance classes and school events. Interestingly, there were two research papers on how dance classes should be organized for sports day from two elementary schools affiliated with universities. For example, group-based (not age-based) longitudinal classes were employed as a part of integrated studies to create their own musical and to present their achievement on sports day. The interviewee who worked at the school also emphasized the importance of the practice by the whole school to build its own curriculum focusing on the musical dance performances on Sports Day. In contrast, the other interviewee, who worked as a member of a dance research group at an elementary school, indicated that most schools did not create classes specialized for dance in conjunction with sports day, but simply provide a choreographed dance for all students, e.g. Yosakoisoran, gymnastics, mass games and so on. **Discussion** Based on these results, the author believes that the content and results of daily dance classes should be considered to be linked to Sports Day, not only on the case of choreographed dance, but also creative free movement using the students' individual creative abilities and group dynamics of many students. It is hoped that more substantial programs for dance classes will be developed in the future through the practice of education in various directions, verification approach and other activities not only in Japan but all over the world. **References** Ministry of Education, Culture, Sports, Science and Technology-Japan, Course of Study, [http://www.mext.go.jp/a\\_menu/shotou/new-cs/youryou/chu/hotai.htm](http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/chu/hotai.htm) Contact hata-no@kobe-shinwa.ac.jp

**EMPIRICAL RESEARCH ON THE DEVELOPMENTAL LEVEL AND DOMAIN OF SPORTSMANSHIP**

Park, J.

*Incheon National University*

Introduction Sportsmanship which resides within sports activities beholds moral conduct. Thus physical education holds an advantage in moral character development. Nonetheless, participating in sports activity alone does not guarantee character development. It is only possible with careful preparation and goal planning. The purpose of this study was to examine the developmental level and domain of sportsmanship in middle school P. E classes. Methods 250 second grade students of middle school in Seoul were applied to the 'Integrated sportsmanship education program'(Park, 2012) developed within basketball, relay and badminton. For data collection: student journals, open questionnaires, participant observation, in-depth interview were done, and these data analyzed in terms of Patton(2002)'s inductive analysis to discover patterns, themes and categories. Also frequency analysis was applied for examining the ratio of sportsmanship developmental level and domain. Results The sportsmanship development of middle school students was analysed following two aspects. First, the developmental level of sportsmanship was categorized as: (a) cynical exploration stage, (b) selfish competition, (c) fair achievement, (d) limited caring, (e) conscientious respect. Second, the developmental domain of sportsmanship was labeled as both mindset-behavior and P. E class-daily life. Discussion & Conclusion sportsmanship education should be developed and implemented for students to experience from social character to moral character and from selfishness to altruism. And they have to reflect their thoughts, attitude, behaviors through practical learning(choi, 2010; Lickona, 1991). Systemic approach is needed for enlarging the sportsmanship to daily life. References Choi, E. C. (2010). Can We teach sportsmanship?, *Korean Journal of Sport Pedagogy*, 17(1), 1-24. Lickona, T.(1991). *Educating for character: How our schools can teach respect and responsibility*, New York: Bantam. Park, J. J.(2012). Exploring of the formation type and aspect of middle school students' sportsmanship through implementation of integrated sportsmanship education program, *Korean Journal of Sport Pedagogy*, 19(2), 93-116. Patton, M. Q.(2002). *Qualitative research and evaluation methods*(3rd ed.), Thousand Oaks. CA: Sage.

**RELATIONS OF PHYSICAL ACTIVITY LEVEL AND MOTOR COMPETENCE OF CHILDREN AGED TEN**

Serbetar, I.

*Faculty of Teacher Education Zagreb*

RELATIONS OF PHYSICAL ACTIVITY LEVEL AND MOTOR COMPETENCE OF CHILDREN AGED TEN Introduction There are many evidences that level of physical activity of the children is declining. Engagement in physical activity is of crucial importance of children's motor, social and cognitive development (Strong et al., 2005). Inactivity, on the other hand, could lower opportunities of acquiring proficiency in motor skills. Such a lifestyle may lead to vicious circle concerning health problem and related movement difficulties (D'Hondt et al., 2009). Although physical activity level is not such directly related to health as fitness is, it is important health related construct (Hands et al., 2008). Present study aimed to investigate relations of motor competence and self-reported physical activity. Methods Research was carried out in North West Croatia and 103 children aged 10 were involved (42 boys and 61 girls). Movement Assessment Battery for Children-2 (MABC-2; Henderson et al., 2007), was applied, as well as The Physical Activity Questionnaire for older Children (PAQ-C; Kowalski et al., 2004). Results In PAQ-C children reported their level of involvement in motor activities in school but also in their spare time. According to the descriptive data of PAQ-C, children were more engaged in sedentary than in movement activities. There were no significant differences between boys and girls neither in PAQ-C nor in MABC-2 total scores, but girls performed significantly better than boys in fine motor skills ( $p=.01$ ). Although low in magnitude, inter-correlations of MABC-2 motor domains were significant (.24 to .30). Correlation between MABC-2 total score and PAQ-C average score was positive but not statistically significant. Discussion Most of the studies proved the positive association of the physical activity and motor competence in children (Wrotniak et al., 2006; Fisher et al., 2005) which was not the case here. It may be the issue of study sample size but it could be also speculated that more valid and objective measure of physical activity than self-report should be used in that age. However, motor competence is not only determinant of physical activity but also the outcome, so it may be the result of high level of physical activity. Unlike motor competence, physical activity is behavior which may be determined by more psychosocial influence than motor competence (Rowland, 2005). Complex causality of these relationships still has to be established. References Henderson, S. E., Sugden, D. A., Barnett, A. L. (2007). *Movement Assessment Battery for Children-2. (Movement ABC-2). Examiner's manual*. London: Harcourt Assessment. Kowalski, K. C., Crocker P. R. E., Donen, R. M. (2004). *The Physical Activity Questionnaire for older Children (PAQ-C) and Adolescents (PAQ-A) Manual*. University of Saskatchewan. [ivan.serbetar@ufzg.hr](mailto:ivan.serbetar@ufzg.hr)

**MARTIAL ARTS AND COMBAT SPORTS AS SCHOOL EDUCATION SUBJECT**

Correia, W.

*University of Sao Paulo*

INTRODUCTION In Brazil, martial arts and combat sports are considered contents of physical education programs of elementary/high schools. Among other relevant activities and learning topics such as sports, gymnastics, dance, games and body health issues, martial arts and combat sports have also been included in the Brazilian public schools curriculum. Moreover, the martial arts include a huge variety of cultural expressions with inherent logic and particular purposes. However, such purposes have been demonstrated to be significantly different from the current physical education teaching process. Therefore, the main aim of this study is to propose invariant criteria for aid in the adoption of the martial arts as a subject of the physical education at elementary and high school. METHOD This study involved a survey of bibliographical and documentary researches from official curriculum documents and literature on curriculum theory applies to physical education, followed by the analysis of features which could be useful to the improvement of learning of martial arts at the school. RESULTS Five relevant items for adequacy of martial arts and combat sports as school education subject were identified: 1) specificity of the school environment; 2) cultural context of the students and their previous interests; 3) growth characteristics and development of children and adolescents; 4) specificity of martial arts and combat sports; 5) training and teaching knowledge. DISCUSSION The results of present study suggest the need for an investment in the pedagogical preparation of physical education teachers taken into account the 5 relevant items for adequacy of martial arts and combat sports as school education subject in a didactic and pedagogical point of view.



14:00 - 15:00

## Mini-Orals

## MO-PM02 Nutrition, training adaptation and performance

**EFFECT OF PROTEIN SUPPLEMENTATION ON MUSCULAR ADAPTATIONS IN RESPONSE TO STRENGTH TRAINING IN ELDERLY ADULTS.**

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**Introduction** Ageing is associated with a progressive decrease in maximal force, in part due to a loss of muscle mass (2). Previous work underscores the relevance to combine essential amino acids supplementation with strength training to increase muscle mass in young men (3). As the increase in muscle mass was greater in subjects with low initial nitrogen balance, such combination may provide more efficient intervention to prevent muscle loss in elderly adults. However, scientific literature on such a topic remains scarce. Therefore, this study investigated the benefits of protein supplementation on muscular adaptations and maximal force in response to strength training in elderly adults. **Methods** 35 elderly adults (>60 yrs) completed the study. Two groups performed a strength training (2 session/week) for 24 weeks. One group (n=13) received placebo (27g carbohydrate) and the other group (n=12) received protein supplementation enrich in leucine (20g protein – 7g carbohydrate). In addition, 10 subjects composed a control group (no training and with placebo). Muscle thickness and pennation angle were recorded by ultrasonography of the gastrocnemius medialis to document changes in muscle mass and architecture. Lean body mass was assessed by DXA. The force of the ankle plantar flexors was assessed during maximal voluntary contractions (MVC). **Results** Training resulted in significant ( $P<0.05$ ) increase in MVC force without any difference between placebo and supplemented groups (24% and 33%, respectively). A similar increase ( $P<0.05$ ) was found in both placebo and supplemented groups for muscle thickness (9.4% and 8.5 %), angle of pennation (13.7% and 15%) and lean body mass (2.5% and 3.4%). However, a negative linear regression ( $r^2=0.33$ ,  $P<0.05$ ) was found between initial lean mass and gain in lean mass after training only for the supplemented group. **Discussion** The results indicate that part of the increase in maximal force is due to muscular adaptations. The lack of a significant effect of protein supplementation may reflect an age-related decrease in sensitivity or responsiveness of intramuscular signalling pathways regulating protein synthesis (1). However, the greater gain in lean mass for subjects having the lower initial value suggests that protein supplementation may have a greater effect on sarcopenic elderly adults. **References** 1. Breen, Phillips (2011). *Nutr Metab* 8:68 2. Clark, Manini (2012). *Nutrition*, 28:495-503. 3. Vieillevoye et al. (2010). *Eur J Appl Physiol*. 110:479-88 Contact Severine.Stragier@ulb.ac.be This study was supported by the Walloon Region of Belgium (Geramino project C6077).

**CAFFEINE AND EXERCISE PERFORMANCE IN ALTITUDE**

Stadheim, H.K., Nossum, E.M., Spencer, M., Jensen, J.  
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Research on the physiological effects following caffeine (CAF) ingestion on exercise performance in normoxia at sea level is extensive. However, there is limited research related to sports performance when athletes are exposed to acute hypoxia. The aim of the present study was therefore to test the effect of placebo and CAF (4.5 mg•kg<sup>-1</sup>) on endurance performance when subjects were exposed to acute hypoxic conditions (2h at 2000m). **Methods:** 13 highly endurance trained male cross-country skiers (VO<sub>2</sub>max-run 72.6±5.68 mg•kg<sup>-1</sup>•min<sup>-1</sup>) participated in the study which had a randomized double-blinded, placebo-controlled, cross-over-design. Performance was assessed as time to complete a 8 km cross-country double poling test (C-PT), and time until task failure at 90% of VO<sub>2</sub>peak-pol-alt. All hypoxic testing where carried out in a hyperbaric chamber where air pressure was reduced to 800 mBar, equivalent of 2000 meters above sea-level at 17 C. **Results:** Ingestion of CAF improved time until task failure during the 90% C-PT ( $P=0.05$ ). During the 8 km C-PT CAF ingestion resulted in improved velocity over the first 4 km, but a non-significant effect was observed for the overall performance ( $P=0.22$ ). However, a 0.9±1.3 (mean ±90% CL) improvement was observed during CAF trials. Improved performance was during all tests associated with increased hear rate peak/mean, VO<sub>2</sub>-consumption, blood lactate, glucose, adrenaline and a decrease in bicarbonate during CAF compared to PLA testing. In addition, during the standardized warm-up prior to each C-PT subjects reported lower perception of pain in arms, and rate of perceived exertion following CAF ingestion. **Discussion/Conclusion:** The present study demonstrates for the first time that CAF ingestion can improve double poling performance when subjects are exposed to acute hypoxic conditions. Mechanisms underpinning observed improvements are due to reduced pain sensation affecting physiological mechanisms for optimal endurance performance. Importantly, the unique design of the study highlights the importance of subjects controlling pacing strategy following CAF ingestion prior to exercise. Especially this seems to be importance during trials where subjects complete a set amount of work, such as during time trial performances (e.g. 8 km C-PT).

**COMBINED INGESTION OF GLUCOSE AND FRUCTOSE DOES NOT FURTHER ACCELERATE POST-EXERCISE MUSCLE GLYCOGEN REPLETION IN TRAINED CYCLISTS**

Trommelen, J., Beelen, M., Pinckaers, P.J.M., Senden, J.M., Cermak, N.M., van Loon, L.J.C.  
*Maastricht University*

**Introduction** Post-exercise muscle glycogen synthesis rate represents one of the more important factors determining the time needed to recover from prolonged exercise. Muscle glycogen synthesis rates are largely determined by the amount of exogenous carbohydrate provided. Carbohydrate absorption from the gut may be accelerated by the ingestion of multiple transportable carbohydrates when compared to the ingestion of glucose or glucose polymers only. We hypothesised that the combined ingestion of glucose and fructose or sucrose further increases post-exercise muscle glycogen repletion rates when compared with the ingestion of an isocaloric amount of glucose only. **Methods** Fourteen male cyclists (age: 28±2 y; Wmax: 4.8±0.1 W•kg<sup>-1</sup>) were studied on 3 different test days. Each test day started with a glycogen-depleting exercise session. This was followed by a 5 h recovery period, during which subjects ingested 1.5 g•kg<sup>-1</sup>•h<sup>-1</sup> glucose (GLU), 1.2 g•kg<sup>-1</sup>•h<sup>-1</sup> glucose + 0.3 g•kg<sup>-1</sup>•h<sup>-1</sup> fructose (GLU+FRU), or 0.9 g•kg<sup>-1</sup>•h<sup>-1</sup> glucose + 0.6 g•kg<sup>-1</sup>•h<sup>-1</sup> sucrose

(GLU+SUC). Blood samples were collected frequently and muscle biopsies were obtained at 0, 2, 5 h after cessation of exercise. Repeated measures ANOVA with time and treatment as within-subjects factors was used to determine differences in muscle glycogen content over time between treatments. Results Post-exercise muscle glycogen content averaged  $207 \pm 30$ ,  $219 \pm 29$  and  $236 \pm 32$  mmol·kg<sup>-1</sup> dry weight in the GLU, GLU+FRU and GLU+SUC treatment, respectively, with no significant differences between treatments ( $P=0.362$ ). Muscle glycogen concentrations increased over time to  $261 \pm 26$ ,  $289 \pm 35$  and  $315 \pm 28$  mmol·kg<sup>-1</sup> dry weight in the GLU, GLU+FRU and GLU+SUC treatment, respectively ( $P<0.001$ ), with no differences between treatments (time x treatment,  $P=0.757$ ). Conclusion Combined ingestion of glucose plus fructose or glucose plus sucrose does not further accelerate post-exercise muscle glycogen repletion in trained cyclists when ample carbohydrate (1.5 g·kg<sup>-1</sup>·h<sup>-1</sup>) is ingested.

### **SUPPLEMENTATION WITH MILK PROTEIN PROMOTES SIMILAR CHANGES IN STRENGTH AND MUSCLE MASS AS ISOCALORIC SUPPLEMENTATION OF NATIVE WHEY DURING 11 WEEKS OF STRENGTH TRAINING IN ELDERLY**

Johansen, M., Hamarsland, H., Seeberg, F., Raastad, T.  
*Norwegian School of Sport Sciences*

**Introduction** Milk proteins, and especially the whey fraction of milk protein, have gained interest because of their effectiveness in stimulating muscle protein synthesis in the first hours after ingestion (1). Whey protein is rapidly digested and absorbed; giving a rapid increase in plasma leucine concentration, which seems to be one of the triggers of muscle protein synthesis (2). Whey protein isolated by a new filtration technique may be a potent stimulator of muscle anabolism because proteins are preserved in a more native form (native whey) and it has a higher concentration of leucine than regular whey. Elderly seems to need higher dosages of the same protein to achieve similar increases in protein synthesis as younger subjects (3). However the 'leucine trigger' hypothesis suggests that fast digestible proteins with high leucine concentrations could lower the optimal protein dose in elderly and thereby promote increases in muscle mass in combination with strength training (4). In this study we investigate whether ingesting native whey protein leads to greater hypertrophy during 11 weeks of strength training than normal milk protein in elderly subjects. **Methods:** A total of 26 elderly subjects (70-88 years) were randomized to either a milk protein or a native whey supplemented group. Both groups performed heavy load strength training over a period of 11 weeks consisting of three supervised exercise sessions per week, following a daily-undulating linear progression. Subjects were supplemented with two doses of 20g of protein per day only differing in protein type (native whey vs. milk protein). The experiment was conducted as a double blinded-randomized controlled trial. **Results** The Native Whey and the Milk protein supplemented group achieved similar gains in lean body mass (measured by DXA) with mean gains of  $1.8 \pm 1.1$  kg (3.7%) and  $2.4 \pm 1.2$  kg (5.2%) respectively. Regional measurements showed an increase in m. vastus lateralis thickness (US) of  $13 \pm 9$ mm (6.1%) for Native Whey, and  $15 \pm 11$  mm (7.2%) for Milk. Strength measured as 1RM in leg press increased by  $37 \pm 16$  % ( $p<0.01$ ) for Native whey, and by  $31 \pm 14$ % for Milk and 1RM in chest press increased by  $22 \pm 7$  % for Native Whey, and  $24 \pm 18$ % for Milk. All changes were significantly different ( $P<0.05$ ) from pre-values, but there were no significant differences between the two groups. The groups were not different in any variables at baseline. Conclusion Our results suggests there was no added effect of consuming native whey protein compared to normal milk on the accumulation of lean mass and increases in strength when given in two 20 g protein doses per day in addition to a normal healthy diet. **References** 1. Hulmi, Lockwood, and Stout. *Nutr.Metab.*7:51, 2010. 2. West, Burd, Coffey, Baker, Burke, Hawley, Moore, Stellingwerff, and Phillips. *Am.J.Clin.Nutr.* 94 (3):795-803, 2011. 3. Dideriksen et al., (2013) *Nutrients*, 5, 852-876 4. Phillips SM.(2013) *Sport Science Exchange Vol 26*, No.107, 1-5

### **DIETARY DETERMINANTS OF THE MAXIMAL CAPACITY FOR FAT OXIDATION DURING EXERCISE**

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**Introduction** Substantial inter-subject variation exists in the maximal capacity to oxidize fat (MFO) during exercise, which may have implications for metabolic health and athletic performance. Venables et al (2005) reported that non-nutritional factors (maximal aerobic capacity [VO<sub>2</sub>max], self-reported physical activity level [SRPAL] and sex) explained 12% of the variability in MFO. Habitual diet is known to affect the metabolic response to exercise yet its influence on MFO has not previously been determined. **Methods** Healthy volunteers (150 Men, 155 Women; age  $25 \pm 6$  yrs.; BMI  $23 \pm 2$  kg/m<sup>2</sup>; VO<sub>2</sub>max  $50 \pm 8$  ml/kg/min [data are mean  $\pm$  SD]) performed an incremental treadmill exercise test with indirect calorimetry employed to determine MFO and VO<sub>2</sub>max. Dual-energy x-ray absorptiometry (DXA) was used to assess body composition. SRPAL and dietary intake (weighed food intake) was recorded for the four days prior to exercise testing. Significant bivariate correlations between MFO and predictor variables were entered into hierarchical multiple linear regression models to quantify each independent variable's influence on MFO. An exploratory analysis of the determinants of MFO within each sex was also performed. **Results** Mean MFO was  $10 \pm 3$  mg/kg fat free mass (FFM)/min (range: 3-20 mg/kg FFM/min), and was greater in women than men ( $11 \pm 3$  vs.  $10 \pm 3$  mg/kg FFM/min,  $P<0.05$ ). VO<sub>2</sub>max (L/min) ( $\beta = .14$ ), sex ( $\beta = .14$ ), fat mass (FM) ( $\beta = -.14$ ) and SRPAL ( $\beta = .26$ ) explained 17.4% ( $P<0.01$ ) of the inter-subject variability in MFO, with dietary carbohydrate (CHO) ( $\beta = -.19$ ), protein ( $\beta = -.13$ ) and fat ( $\beta = .15$ ) intake explaining an additional 3.1% ( $P<0.01$ ) of the variance. In men, the majority of the explained variance in MFO could be attributed to VO<sub>2</sub>max ( $\beta = .18$ ) and SRPAL ( $\beta = .22$ ) (12.6%,  $P<0.01$ ), with the intake of protein ( $\beta = -.17$ ) and CHO ( $\beta = -.15$ ,  $P=0.10$ ) explaining an additional 2.5% ( $P<0.05$ ). In women, the majority of the explained variance in MFO could be attributed to SRPAL ( $\beta = .32$ ) and FM ( $\beta = -.18$ ) (19.3%,  $P<0.01$ ), with the intake of CHO ( $\beta = -.21$ ) and fat ( $\beta = .19$ ) explaining an additional 4.3% ( $P<0.01$ ). **Discussion** Previously identified non-nutritional determinants of MFO comprised the majority of the explained inter-subject variation in MFO while habitual dietary intake of CHO, fat and protein made modest additional contributions. Our exploratory analyses suggest that the intakes of protein for men but fat and CHO for women make additional contributions to MFO. In conclusion, habitual macronutrient intake is an additional modifiable factor to the previously identified determinants of MFO, which could be targeted in interventions aiming to optimise metabolic health and athletic performance. **References** Venables et al (2005). *J Appl Physiol* 98:160-167 Contact GXF243@bham.ac.uk

### **EFFECTS OF DIFFERENT TIMING OF ICE SLURRY INGESTION BEFORE EXERCISE ON ENDURANCE EXERCISE CAPACITY AND THERMOREGULATION**

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**Introduction** Ice slurry ingestion has been recently attracted attention as precooling procedure before exercise. It may not cause the decrease in muscle temperature, so it may be more effective to ingest ice slurry immediately before exercise. However, most previous

studies using ice slurry treated precooling only before warm-up (W-up) and the appropriate timing of ice slurry ingestion has been unclear. The purpose of this study was to investigate the effect of difference in the timing of ice slurry ingestion before or after W-up on endurance exercise capacity and thermoregulatory response in a warm environment. Methods Nine active male subjects completed three experimental cycling trials at 55% maximum voluntary exercise to exhaustion at 30°C and 80% relative humidity. Three experimental conditions set for thermoneutral water (37°C) ingestion both before and after W-up (CON), ice slurry (−1°C) ingestion before W-up and water ingestion after W-up (PRE), water ingestion before W-up and ice slurry ingestion after W-up (POST). Subjects ingested 7.5 g/kg drinks within 15 min both before and after W-up. Exhaustion was considered to have occurred when the subject was unable to keep pace (60 rpm) or rectal temperature reached at 39.5°C. Results In POST, time to exhaustion was significantly longer than CON (POST : 59.8±9.8 min, CON : 52±12.6 min,  $P < 0.05$ ). Rectal temperature (Tre) and mean skin temperature (Tsk) at the beginning of exercise in POST was significantly lower than CON and PRE ( $P < 0.05$ ). Tre at exhaustion in PRE tended to be higher than CON ( $P = 0.099$ ) and POST ( $P = 0.069$ ). The rate of increase in Tre during exercise ( $\Delta$ Tre) in PRE tended to be higher than CON ( $P = 0.051$ ). Heart rate, thermal sensation and rating of perceived exertion during exercise were not different among the three conditions. Discussion Endurance exercise capacity in POST was improved due to the following two mechanisms. First, the decrease in Tre increased heat storage capacity (Siegel et al., 2012) and led to delay reaching the exhaustion. Second, the decrease in Tsk increased peripheral heat storage capacity (Kay et al., 1999) and this may prevent larger  $\Delta$ Tre by easier core-to-skin heat transfer. On the other hand, endurance exercise capacity in PRE was not improved because of larger  $\Delta$ Tre. Some previous studies which ingested ice slurry also reported larger rate of increase in core temperature. This may impair the effect of precooling. Moreover, many subjects in PRE completed exercise with higher Tre, so ice slurry ingestion before W-up may cause heat illness. Therefore ice slurry ingestion after W-up is more safety and effective for the exercise capacity in the heat. References Siegel R et al. (2012) J Sports Sci 30(2): 155-65. Kay D et al. (1999) J Sports Sci 17(12): 937-44.

### THE INFLUENCE OF BEETROOT JUICE ON RECOVERY FROM A SINGLE BOUT OF STRENUOUS EXERCISE

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Introduction Exercise induced muscle damage (EIMD) is characterised by muscle soreness, acute inflammation and impaired muscle function. These symptoms can persist for several days, and subsequently hamper recovery. Emerging evidence suggests that supplementation with antioxidant rich foods might attenuate EIMD and hasten the recovery of muscle function. Red beetroot is a rich source of phenolic compounds and also contains a group of bioactive pigments known as betalains, which possess potent antioxidant and anti-inflammatory functions that might facilitate recovery following strenuous exercise. Thus, the aim of this study is to investigate the effects of beetroot juice on recovery following a single bout of muscle damaging exercise. Methods This study employed a double blind, placebo controlled, independent groups design. Thirty recreationally active males were allocated to consume a high dose beetroot juice (250 ml), a low dose beetroot juice (125 ml), or an isocaloric placebo immediately after, 24 and 48 h following 100-drop jumps. Muscle function (maximal voluntary contraction: MVC, countermovement jump: CMJ, reactive strength index: RSI), muscle soreness (visual analogue scale: VAS, pressure-pain threshold: PPT) and blood indices of skeletal muscle damage (creatinase: CK) were measured pre, post, 24, 48 and 72 h following the drop jumps. Results CMJ performance recovered quicker in the high beetroot juice group vs. placebo at 48 (-8.3 ± 12.4% vs. -25.6 ± 13.14% of baseline value;  $P = 0.008$ ) and 72 h post exercise (-6.6 ± 7.7% vs. -14 ± 5.9% of baseline value;  $P = 0.046$ ). There were no significant group differences for MVC and RSI ( $P > 0.05$ ). PPT was significantly reduced in the placebo vs. both the high and low beetroot juice groups at 24, 48 and 72 h post exercise ( $P < 0.001$ ). No group differences were detected in subjective muscle soreness, as measured with the VAS, or CK ( $P > 0.05$ ). Discussion The primary findings of this study were that beetroot juice; 1) attenuated the loss in muscle force generating capacity, as measured by improved CMJ performance, and; 2) reduced muscle soreness, as indicated by an increase in PPT. Furthermore, a dose-dependent response was also evident given that only the high beetroot juice dose improved CMJ performance. Potentially, beetroot juice blunted the acute inflammatory response, which may have limited further structural damage to the muscle cell; however, we did not measure inflammation and therefore further studies are required to confirm the current observations and to clarify the potential mechanisms behind these findings. Notwithstanding, beetroot juice may serve as a useful strategy to accelerate recovery following strenuous exercise, at least in recreationally active males. Contact tom.clifford@northumbria.ac.uk

### ACUTE EFFECTS OF GUM CHEWING AND HIGH INTENSITY EXERCISE ON APPETITE-REGULATING HORMONES AND ENERGY INTAKE

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Introduction An acute bout of exercise is one important strategy that has been shown to consistently induce a reduction in relative energy intake, taking into account the cost of exercise (1), and alter appetite-regulating hormones, including ghrelin and peptide YY (PYY) (2) in humans. However, the acute effects of increased mastication by gum chewing on appetite-regulating hormones and energy intake are unclear. In addition, no data are available regarding the combined effects of gum chewing and exercise on appetite-regulating hormones and energy intake. The main purposes of this study were to examine the effects of gum chewing/the combined effects of gum chewing and exercise on appetite-regulating hormones and energy intake. Methods Fourteen healthy young men (age 21.4 ± 1.2 years) underwent five, 1-day trials in a randomised order: 1) control, 2) gum chewing, 3) exercise, 4) gum chewing + exercise and 5) exercise + gum chewing. In trials that include gum chewing, the participants chewed gum 60 times per minutes for 30 minutes between 0800 and 0900 depending on the trial order. In trials that include exercise, the participants ran for 30 minutes at 80.0 ± 5.6% of heart rate reserve between 0800 and 0900 depending on the trial order. The participants then rested 3 hours until an ad libitum buffet lunch provided between 1200 and 1300. Energy intake was measured in ad libitum buffet lunch between 1200 and 1300. Plasma concentration of ghrelin and P YY were measured at 0800, 0830, 0900, 1030, 1200 and 1300. Results There were no between-trial differences in appetite-regulating hormones (two-factor ANOVA, ghrelin,  $P > 0.05$ ; PYY,  $P > 0.05$ ) and absolute energy intake (one-factor ANOVA,  $P > 0.05$ ) among trials, including the gum chewing trial. The combination of gum chewing and exercise did not alter appetite-regulating hormones (two-factor ANOVA, ghrelin,  $P > 0.05$ ; PYY,  $P > 0.05$  for trial effects) and absolute energy intake (one-factor ANOVA,  $P > 0.05$ ). Relative energy intake was lowered in the exercise trials (Gum chewing + exercise, 336 ± 169 kJ; Exercise + gum chewing, 278 ± 140 kJ) than the gum chewing (440 ± 123 kJ) (one-factor ANOVA,  $P \leq 0.137$ ) and/or control trials (446 ± 145 kJ) (one-factor ANOVA,  $P < 0.05$ ). Discussion These findings suggest that gum chewing may not play a role in short-term appetite regulation. Our findings, however, support the previous study (1) that in response to an acute bout of high intensity exercise, individuals do not compensate for the expended energy by increas-

ing their food intake at least 3 h afterward. References 1. King JA, Miyashita M, Wasse LK, Stensel DJ. *Appetite*. 2010;54:492-498. 2. Kawano H, Mineta M, Asaka M, Miyashita M, et al. *Appetite*. 2013;48:26-33.

## Mini-Orals

### MO-BN03 Kinematics

#### SPECIFIC BIOMECHANICAL DIFFERENCES EXIST ACROSS SKILL LEVELS FOR HIGH VELOCITY FOOTBALL KICKS

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**Introduction** One of the most important movements in a football game is the kick, yet little is known about specific biomechanical variables that differ between skill levels. Variables that have been found to affect performance for high velocity kicks include a high knee angular velocity and a plantarflexed ankle (Shan and Westerhoff, 2005). Quadriceps and hamstring muscles are most active during the terminal stage of backswing and prior to ball contact (De Proft et al., 1988). This study's objective was to understand functional aspects of technique that differ between athletes. We hypothesized that biomechanical variables would differ between skill levels, particularly at the foot/ankle level. **Methods** Ten male participants were classified into a high and a low level group. They were instructed to perform ten high velocity kicks each. Muscular activity was measured from 6 muscles of the kicking and support leg using electromyography (EMG), full body kinematics were obtained using 3D motion capture, and the velocity of the ball was recorded using a radar gun. Wavelet analysis was used to resolve EMG data into intensities, and joint angles and segment angular velocities were calculated from the kinematic marker trajectories. **Results** High level athletes had less deviation of the foot angular velocity at contact with the ball ( $p=0.03$ ), a greater thigh angular velocity throughout the kick ( $p=0.01$ ), and a more abducted kicking leg at ball contact ( $p=0.045$ ) compared to low level athletes. The EMG intensity of the high level group was greater for the gastrocnemius and biceps femoris muscles ( $p=0.07$  and  $0.03$ , respectively) throughout the kick. **Discussion** The results support the hypothesis that high and low level football players display distinct biomechanical differences. The lower deviation in the foot's angular velocity at ball contact for the high level group indicates their ability to stiffen the ankle, which they achieve through greater muscle activity of the gastrocnemius muscle. We speculate that the greater hip abduction allows the athlete to impact the ball at a different location and orientation of the foot. The greater biceps femoris muscle activation was likely a consequence of actively extending the hip during backswing, and slowing down the leg at the end of follow-through. These findings, combined with a real time foot swing and orientation monitoring device, can be used in the development of a virtual coaching system aimed at helping recreational football players achieve a greater ball velocity. **References** De Proft E, Clarys J, Bollens E, Cabri J, Dufour W (1988). Muscle activity in the soccer kick. *Sc. & Football*. 434 - 474. Shan G, Westerhoff P (2005). *Sports Biom*, 4(1), 59-72 Contact Max Bauer [max.bauer@technikum-wien.at]

#### DIFFERENCES IN RANGE OF MOTION AND FEET PRESSURE BETWEEN SKIING WITH AND WITHOUT RIFLE IN FEMALE BIATHLETES.

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**Introduction** Biathlon combines cross-country skiing (CCS) while carrying a rifle and rifle marksmanship. During CCS the biathletes use skating technique. In skating the most used gear is gear 3 (Andersson et al. 2010) that is used in light and moderate uphill. Carrying the rifle during CCS affects the biomechanical responses (Stöggl et al. 2014) but less is known about how carrying a rifle affects the range of motion and feet pressure during CCS in gear 3. **Methods** Seven well trained female biathletes (19±1 years, 1,65±0,07 m, 62±6 kg) were skiing 4 laps on snow using gear 3 skating technique on a 1250 m long track. The skiing velocity was as to be "racing speed" and two laps were skied with rifle (R) and two laps without (NR) in a randomized order. The weight of the subjects rifles was 4,0 ± 0,2 kg. The athletes were wearing a 3D-suit (Noraxon) with 16 measuring points (sampling frequency, SF, 200 Hz) and pressure insoles (Moticon) in their shoes (SF 50 Hz). **Results** The skiing times for the laps was shorter with NR compared to R (196±12 vs 201±12 s,  $p<0,01$ ) although the average heart rate was similar (89±3% of HRmax for both NR and R). In a specific uphill section, six cycles of gear 3 skating technique were analyzed. No difference in cycle time was found between R and NR (1,88±0,10 vs 1,87±0,14 s). Range of motion was smaller for R than NR in knee flexion (left: 30±7 vs 32±5°,  $p<0,05$ ; right: 31±4 vs 33±4°,  $p<0,05$ ), shoulder flexion (left: 74±13 vs 88±10°,  $p<0,05$ ; right: 59±18 vs 85±5°,  $p<0,01$ ) and hip flexion (left: 32±8 vs 42±3°,  $p<0,01$ ). Feet pressure was higher in the two zones in the center of the medial part of the feet in R compared to NR (left: 2,4±1,3 and 5,1±1,2 vs 2,2±1,3 and 4,9±1,1 N/cm<sup>2</sup>,  $p<0,05$  and  $p<0,01$ ; right: 2,02 ± 1,22 and 3,22 ± 1,27 vs 1,85 ± 1,21 and 2,96 ± 1,15 N/cm<sup>2</sup>, both  $p<0,05$ ). **Discussion** Carrying a rifle decreases the range of motion in shoulder, knee and hip flexion for female biathletes. In addition, the increased pressure in the medial part of the feet indicates changed balance pattern during skiing with rifle. These findings are in line with Stöggl et al. (2014) who showed changed skiing biomechanics when carrying rifle. These aspects should also be considered in biathlon training. **References** Andersson, E., Supej, M., Sandbakk, Ø., Sperlich, B., Stöggl, T. & Holmberg, H.C. (2010). Analysis of sprint cross country skiing using a differential global navigation satellite system. *European Journal of Applied Physiology*, 110, pp. 585-595. Stöggl, T., Bishop, P., Höök, M., Willis, S. & Holmberg, H.C. (2014). Impact of carrying a rifle on physiology and biomechanical responses in biathletes. *Medicine and Science in Sports and Exercise* (pub ahead of print).

#### GAIT ANALYSIS OF OBESE ADOLESCENT'S UPHILL WALK: KINEMATIC AND KINETIC ADAPTATIONS COMPARED TO NORMAL WEIGHT ADOLESCENTS

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**Introduction** Obesity can already contribute in childhood and adolescents to orthopaedic problems (e.g. Shultz et al., 2009). Weight loss programs often include walking and hiking, however, limited knowledge about the joint loading induced by inclined gait exists. Obese adults are exposed to lower joint loading when walking uphill with slower gait velocity (Ehlen et al., 2011), but it is not known which mechanism occur for adolescents walking with same speed of normal weight peers. **Methods** Ten obese (15 ± 2 yrs, 88.6 ± 16.8 kg) and 16 normal weight adolescents (15 ± 2 yrs, 52.4 ± 5.9 kg) were asked to walk a with two force plates (AMTI, 1000 Hz) instrumented ramp with

the inclinations 0°, 6° and 12° with a speed of 1.1 m/s. Kinematic data were analysed with an 8 camera motion capture system (Vicon, 250Hz). Temporo spatial gait parameters, maximal vertical ground reaction force (vGRF) and sagittal knee angle and joint moment were statistically analysed using a 2 factor ANOVA (weight x inclination). Kinetic data was normalized to bodyweight. Results Inclination had a significant effect on all parameters except step width, while the obese adolescents showed significantly longer relative stance times, higher peak absolute vGRF (peak 1 and 2), but lower relative vGRF (peak 2). Additionally higher knee flexion angles were observed in all inclinations for obese participants. However, the relative sagittal knee joint moment was similar between both weight groups. Discussion Ehlen et al. demonstrated that walking uphill with equal metabolic cost results in lower walking speed, but also lower knee joint moments for obese adults. This study demonstrates, that using the same gait velocity, obese adolescents walk uphill with higher knee flexion angles (approx. 10°) than their normal weight peers, but that their relative knee joint moment was equal to their normal weight counterparts. This supports the theory of DeVita & Hortobágyi (2003) from level walking that obese individual can reorganize their neuromuscular function during gait to maintain skeletal health, even though the strategy chosen differed in this study's population. References DeVita P, Hortobágyi, T. (2003). *J Biomech*, 36, 1355-62. Ehlen, K.A., Reiser, R.F., Browning, R.C. (2011). *Med & Sci Spo & Exerc*, 43, 1251-1259. Shultz, S.P., Anner, J., Hills, A.P. (2009). *Obes Rev*, 10, 576-582. Contact Gerda.strutzenberger@sbg.ac.at

### DAILY CHANGES OF INDIVIDUAL GAIT PATTERNS

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Introduction Biomechanical diagnoses and clinical interventions typically assume nearly constant movement patterns in their subjects. Clinical gait analysis often seeks to evaluate intervention related changes in walking by averaging the data from a number of trials and compare these average values to control subjects that did not undergo an intervention or to previous measurements in a pre-post-design. Despite the knowledge of continuous changes in living systems, movement variability without an intervention is neglected as insignificant in many approaches of movement analysis (Newell et al., 2006). The aim of this study is to look for the reliability of gait patterns from different test days by means of support vector machines. Methods Eight healthy and physically active subjects (23.5 ± 2.3 years) performed 15 gait trials at a self-selected speed on each of the eight test days within two weeks under barefoot conditions. For each trial, the continuous ground reaction forces (Kistler, 1000 Hz) and lower body joint angles (Qualisys, 250 Hz) of one gait cycle were analyzed. An eight-day-classification and one-on-one-classification of support vector machines were carried out for each subject individually. The classification rates were provided by the Liblinear Toolbox 1.4 (Fan et al., 2008) using a leave-one-out cross-validation. Results The mean classification rates for the eight-day-classification are sagittal (71.4 ± 10.4%), frontal (90.7 ± 8.4%), coronal (92.1 ± 8.2%) and combined (95.9 ± 5.8%) joint angles. The mean classification rates for the eight-day-classification are fore-aft (49.6 ± 9.2%), medial-lateral (49.5 ± 9.9%), vertical (48.4 ± 8.7%) and combined (60.1 ± 9.2%) ground reaction forces. The mean classification rates for the one-on-one-classification are sagittal (88.7 ± 5.7%), frontal (95.9 ± 2.2%), coronal (96.9 ± 2.1%) and combined (98.1 ± 1.1%) joint angles. The mean classification rates for the one-on-one-classification are fore-aft (82.5 ± 7.7%), medial-lateral (80.9 ± 6.1%), vertical (83.2 ± 8.2%) and combined (86.1 ± 6.7%) ground reaction forces. Discussion The eight-day-classification rates of 95.9% and 60.1% clearly differ from a random classification of 12.5% and show natural differences between the gait patterns of different days. Hence, changes in gait patterns appear naturally without a specific intervention between the test days. Additionally, the one-on-one-classification points out a general problem of studies with pre-post-design. References Fan RE, Chang KW, Hsieh CJ, Wang XR, Lin CJ (2008). *Journal of Machine Learning Research*, 9, 1871-4. Newell KM, Deutsch KM, Sosnoff JJ & Mayer-Kress G (2006). *Movement system variability*, 3-23. *Human Kinetics*, Champaign (Ill). Contact horst@uni-mainz.de

### A KINEMATIC COMPARISON OF NON-MOTORIZED TREADMILL AND OVERGROUND WALKING

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Introduction Motor-driven treadmill is often used in gait analysis and gait training. Many researchers compared gait parameters such as step frequency and step length as well as kinematic and kinetics during gait on treadmill to normal gait on ground. Recently, curve-shaped non-motorized treadmill was developed for walking. However, the special configuration (curve-shape) which gives to human body during walking movement has not well understood. The purpose of this study was to compare the kinematic parameters during walking on curve-shaped non-motorized treadmill (TM) to those of obtained from normal overground (OG) at identical speed condition. Methods Ten health young subjects (age: 25.0±3.7yrs, BH: 172.3±3.5cm, BW: 68.9±7.8kg) walked 12m walkway at preferred speed. Motion capture (VICON MX20 Oxford: 200fps) and force plate data (Kistler: 1000Hz) for full gait cycle were recorded. The average walking speed of OG trials was used for the TM trials (Curve: Woodway) and TM belt speed were visual feedback to a subject. Spatio-temporal parameter, lower limb joint angle and joint angular velocity data were compared with between TM and OG conditions. Results and Discussion Walking speed of both conditions were quite similar. Significant higher stride frequency and shorter stride length on TM walking was indicated compare with OG condition (p<0.001). Flexion angles at hip and knee were significantly different between TM and OG walking during swing phase (p<0.05). Peak angular velocities at hip and knee were higher in TM than OG (p<0.05). Conclusions Curve-shaped non-motorized treadmill was characterized as higher stride frequency as well as higher flexion angular velocities at hip and knee during swing phase. Reference Alton F, Baldey L, Caplan S, Morrissey MC. (1998). *Clin Biomech*, 13, 434-440. Riley PO, Paolini G, Della Croce U, Paylo KW, Kerrigan DC. (2007). *Gait Posture*, 26, 17-24. Contact {tomoyahirano@outlook.jp}

### USE OF MOTION CAPTURE SYSTEM IN RUSSIAN TEAMS TRAINING FOR SOCHI OLYMPIC GAMES

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Introduction A Qualisys Motion Capture System was part of a testing complex used by the Russian national teams during their preparation for the Winter Olympic games 2014. Methods The test complex consisted of 18 cameras Oqus 300 (AB Qualisys, Sweden), two AMTI force plates (AMTI, USA), and Cortex gas analyzer (Cortex, Germany), extra-wide treadmill (Fitnex, USA). Top Russian athletes, candidates for National Olympic teams in cross-country skiing (n=18), bobsleighbing (n=24), ski jumping (n=8), Nordic combined (n=8), freestyle skiing moguls (n=18), curling (n=6), luge (6), biathlon (12), speed scating (8), curling (6). As a rule, testing was done at the end of each stage of a year-long training cycle. Testing procedures were adjusted taking into account specificity of every sport discipline. Specific software pack-

ages for data processing and generating of final protocols for coaches were developed. Results For cyclic sports high-speed video records helped to estimate mechanical efficacy of the locomotion at each stage of the test taking into account intra-cyclic angular and temporal parameters of displacement of lower extremities' joints and the center of mass, as well as changes in potential and kinetic energy of the athlete's body. Functional capacity and effectiveness of energy supply in skiers and biathletes was estimated during a graded exercise test performed Sports based on strength&velocity qualities. Biomechanical parameters registered in specific tests helped to reveal peculiarities of movement control in movements with complex coordination, estimate realization efficacy of competitive exercise technique, and assess strength and velocity qualities in athletes. Results help coaches to estimate potential abilities of the athletes and develop individual plans of strength training for each of them. Contact mshtv@mail.ru

### ALGORITHM FOR BIOMECHANICAL RESEARCH OF A COMPETITIVE ROUTINE IN TRAMPOLINE

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Introduction In recent years, the biomechanical research in sport, including gymnastic disciplines, played a major role in the science research. The review of the information sources [1-13] on the issue showed that the technique of single exercises is mainly studied. This fact led to the idea to explore the whole competitive routines in trampoline. The purpose of this paper was to explore the main kinematic parameters of sports technique in trampoline during the execution of the competitive routine. In order to achieve the objective the following tasks were decided: 1. Video shooting of the first trampoline routine by observing the special requirements of biomechanical research. 2. Preparation of the video for working with computer programs. 3. Kinematic study of a competitive routine by using specialized software. 4. Elaboration of algorithm to study the technique of a whole routine in trampoline. Methods The study was realized by using the following scientific methods: videocyclegraphy, acselelography, kinematic analysis and others. Results Results include an analysis of the kinematic parameters, which were registered during the implementation of first routine in trampoline. It contains ten exercises. The analysis of collected data caused several conclusions. On this base, an algorithm for researching the technique of execution of the whole competitive routine was presented. Bibliography: 1. Angelov, Vl., Classification Structure of Exercises on Trampoline. Ruse, 2011. 2. Angelov, Vl., Composite Construction of Competitive Routines in Trampoline, magazine 'Sport and Science', extra. pc. 2, Sofia, NSA 'V. Levski', 2012, p. 68-74. 3. Gaverdovskiy, Yu. K. Methodology of a Technique Analysis of Gymnastic Exercises, magazine „Theory and Practice of Physical Culture” pc. 2/1963, p. 1. 4. Gaverdovskiy, Yu. K., V. M. Smolevskiy. Sports gymnastics. M. FIS, 1979. 5. Gaverdovskiy, Yu. K. Technique of Gymnastic Exercises. M., Terra-sport, 2002. 6. Danilov, K. Yu Exercises on Trampoline. M. FIS, 1978. 7. Danilov, K. Yu Training of Competitor in Trampoline. M. FIS, 1983. 8. Donskoy, D. D, Biomechanical Base of Sport Technique. M. FIS, 1971, p. 288. 9. Donskoy, D. D., V. M. Zatsiorskiy. Biomechanics. M. FIS, 1979. 10. Kuryis, V. N. Complexes and Scientific Methods for Researching the Techniques like a Way to Improve the Training Process in Tambling, magazine „Gymnastics”, pc. 2/1974. 11. Kuryis, V. N., V. M. Smolevskiy. Complex Exercises on Tambling. M. FIS, 1985. 12. Mikov, T., N. Milev, Pavlov, N. Hristov. Sports acrobatics. Textbook for professionals., S., NSA - IPD, 1990. 13. Skakun, V. A. Exercises on Tambling. Stavropolskoe knizhnoe izdatelstvo, 1990. Contact Mob.:+(359) 893396300 E- mail: angelov\_vl@abv.bg

### EFFECT OF BODY MASS ON KINETIC VARIABLES DURING A BASKETBALL LAYUP

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Introduction Basketball is a sport which places a considerable amount of stress on the lower extremities of players. Inability to attenuate excessive impact forces on the body might lead to injury (Lephart, 2002). Individual characteristics such as body mass, joint stiffness or landing technique might have an effect on landing forces. The aim of this study was to investigate if an individual's body mass would influence kinetic variables during the performance of a basketball layup. Methods Thirty male university basketball players (age: 21.80 ± 2.77 years) participated in this study. Only participants with a foot length of US size 9.0 ± 0.5 for both feet were recruited. Participants were categorised into two different groups according to their body mass: "heavy" (mass: 82.66 ± 4.31 kg, height: 1.81 ± 0.03 m) and "light" (mass: 63.11 ± 2.79 kg, height: 1.74 ± 0.04 m). Each participant performed five layups in the same size US 9.0 shoe (Li Ning prototype with a plain midsole of shore 42C). Vertical ground reaction forces (vGRF) of the first step (right leg) and landing (double-leg) of the layup were captured at 1 kHz using two 0.9 m x 0.9 m wood-top force platforms. Peak vGRF and mean loading rate (LR), normalised to body weight (BW), were analysed. Results Rearfoot mean LR during the first step of the layup was significantly higher ( $p = .027$ ) in the "heavy" group (77.8 ± 24.8 BWs-1) compared to the "light" group (57.6 ± 22.4 BWs-1). There were no significant differences in rearfoot peak vGRF, forefoot peak vGRF and forefoot LR between groups during the layup first step. During the landing of the layup, no significant differences in any kinetic variables were found. Discussion For all participants, the initial ground contact of the layup first step was made with the heel and this contact with the ground is also known as the impact phase of a step. Higher rates of loading during this impact phase have been found to correlate with higher incidences of lower limb injuries (Hamill et al., 2008). This suggests that heavier players may be exposed to a greater risk of overload injuries at the lower limbs than lighter players when performing layup maneuvers. Conclusion Heavier players and their coaches should be mindful of the higher loading during movements similar to a basketball layup. Proper footwear and landing technique could help attenuate these impact forces and their effect on cushioning deserves further investigation. It would also be useful to examine how body mass affects lower limb kinematics and multiple joint loadings during realistic sporting tasks. References Lephart S. (2002). J Athl Training, 37, 71-79. Hamill J, Miller R, Noehren B, Davis I. (2008). Clin Biomech, 23, 1018-1025. Contact dnin1@ntu.edu.sg

## Mini-Orals

MO-PM05 Oxygen transport, VO<sub>2</sub>max and energy expenditure

## OXYGEN TRANSPORT, DIFFUSION AND UTILIZATION DURING SPRINT EXERCISE IN HUMANS

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**Introduction** The contribution of the aerobic metabolism has been considered almost negligible for all-out sprint exercise lasting up to 10s. However, leg VO<sub>2</sub> during whole body sprint exercise has never been measured in humans. Therefore, the aim of this study was to determine the contribution of convective and diffusive limitations to VO<sub>2</sub>peak during sprint exercise in humans. We hypothesised that in severe hypoxia (Hyp), but not in normoxia (Nx), sprint performance is limited by O<sub>2</sub> delivery, the kinetics of O<sub>2</sub> off-loading from the hemoglobin (Hb) and muscle O<sub>2</sub> diffusing capacity (MDO<sub>2</sub>). **Methods** Oxygen transport and haemodynamics were measured during incremental exercise to exhaustion (IE) and 120 min later, Wingate test, both in Nx (PIO<sub>2</sub>:143 mmHg) and severe hyp (PIO<sub>2</sub>:73 mmHg) in 11 men (22±2 yr). Isokinetic Wingate tests (Lode, 80 rpm) were carried out with 6-7% carboxihaemoglobin (COHb) in blood to left-shift the oxyhaemoglobin dissociation curve. Leg VO<sub>2</sub> was measured by the Fick method, and leg blood flow (BF) with thermodilution. MDO<sub>2</sub> was calculated by numerical integration (PMID: 15919729). **Results** The mean power output (MPO) during the 30s sprint was reduced by 7% in Hyp (P<0.05). During the first 10 s of sprint, MPO was 12% lower in Hyp than Nx (567±90 and 499±86 w, P<0.05). This suggests a central (neural) limiting mechanism at the start of sprint, since leg VO<sub>2</sub> was similar in Nx and Hyp (131±34 and 129±26 ml, respectively P=0.87), and pulmonary VO<sub>2</sub> as well (452±145 and 478±108 ml, P=59). Wingate peak leg BF, leg O<sub>2</sub> delivery and leg VO<sub>2</sub> were, 5, 28 and 23% lower in Hyp than Nx (P<0.05). Peak Wingate MDO<sub>2</sub> was 20.5±3.0 and 51.5±9.7 ml min<sup>-1</sup> mmHg<sup>-1</sup>, in Nx and Hyp (P<0.05). Despite similar PaO<sub>2</sub> during IE and Wingate tests in Hyp (33 and 34 mmHg), as well as similar mean capillary PO<sub>2</sub>, peak perfusion, and vasodilation near exhaustion, peak MDO<sub>2</sub> was 12% higher during sprint than IE in Hyp. Apparently, MDO<sub>2</sub> was insensitive to COHb (0.7 vs 7%, in IE Hyp and Wingate Hyp, P<0.05). At exhaustion, the Y equilibration index was well above 1.0 in both conditions, reflecting greater convective than diffusive limitation to the O<sub>2</sub> transfer in Nx and Hyp. **Discussion and conclusions** We have shown that muscle VO<sub>2</sub> during sprint exercise is not limited by O<sub>2</sub> delivery, the O<sub>2</sub> off-loading from the haemoglobin or structure-dependent diffusion constrains in the skeletal muscle of young healthy men. Moreover, a remarkable functional reserve in muscle O<sub>2</sub> diffusing capacity still available at exhaustion during exercise in Nx, which is recruited during exercise in Hyp. Severe hypoxia reduces sprint performance by central mechanisms even in short sprints. **Acknowledgements** MINECO Spain (DEP2009-11638).

## ENERGY COST OF BACKWARD RUNNING AT POSITIVE GRADIENTS

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**Introduction** Backward walking (BW), on level, has a greater (100%) energy cost (C) than forward walking (FW) due to an impaired ability to exchange potential and kinetic energy. On gradients (+15-32%), C of FW increases according to a reduced capacity to use the pendulum-like mechanism, and the difference between BW and FW is reduced to 5-8% (Minetti & Ardigò, 2001). As for running on level, C of backward running (BR) is 30% higher than forward running (FR) (Flynn et al, 1994). A greater external work, and an higher stride frequency (SF) (internal work) explain only part of the higher C in BR. A lower efficiency in BR attributable to a reverse landing-take off asymmetry, and therefore a lower elastic recoil, seems to be another possible explanation for this discrepancy (Cavagna et al., 2011). To our knowledge, C during BR on gradient has not yet been determined. **Aim** of this study was to compare C of BR and FR on positive gradients. Since in FR store and release of elastic energy decrease with gradient, we hypothesized that the difference in C between BR and FR reduces with the gradient. **Methods** Tests were performed on 10 young (age 26±3 yr) male athletes (V̇O<sub>2</sub>peak 64.5±2.1 ml\*kg<sup>-1</sup>\*min<sup>-1</sup>). Subjects ran both forward and backward several 5-min bouts on an electrically driven treadmill. Gradient was modified from 0% to 20%. Breath-by-breath oxygen consumption (V̇O<sub>2</sub>) was measured and C was calculated using resting and steady-state V̇O<sub>2</sub> values. SF was obtained by analysing the periodicity in the 30-s video recording (240 Hz). **Results** On level, C was significantly (p<0,01) higher in BR than in FR (5,41±0,67 vs 3,70±0,43 J\*kg<sup>-1</sup>\*m<sup>-1</sup>). A linear relationship between C and slope was found both in BR (r<sup>2</sup>=0,98, p=0,001) and in FR (r<sup>2</sup>=0,99, p<0,001). The difference in C between BR and FR did not decrease with the gradient, setting to a value of 35%. SF did not change with the gradient in FR, and it was significantly (p<0,05) higher in BR than in FR on every gradients. **Discussion** This is the first study showing C of BR on gradient. Differently from walking, gradient did not affect the difference in C between BR and FR. These results confute our hypothesis and lead to suspect that elastic energy utilization is not the main responsible for the higher C of BR. The difference in C between BR and FR could be partially explained by a different internal work, as suggested by a higher SF in BR. Further studies are needed to better clarify the biomechanical aspects of BR at different gradients. **References** Minetti AE & Ardigò LP (2001) Pflügers Arch-Eur J Physiol 442:542-546 Flynn TW, Connery SM, Smutok MA, Zeballos RJ, Weisman IM (1994) Med Sci Sports Exerc 26:89-94 Cavagna GA, Legramandi MA, La Torre A (2011) Proc R Soc Lond B 278:339-346

IS THE VO<sub>2</sub>MAX INTENSITY AN EFFECTIVE STIMULUS FOR THE 2000M ROWING RACE?

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**Introduction** Olympic rowing races are conducted over a 2000m distance, with 85% of estimated aerobic energy contribution (Mello et al., 2009). In fact, the power associated with the maximal oxygen consumption (VO<sub>2</sub>max) intensity has been described as an important determinant of the 2000m rowing performance and frequently used as a training stimulus for the 2000m race (Ingham et al., 2013). However, the comparison of the VO<sub>2</sub> kinetics between these two intensities has not been done, still being unanswered if the corresponding physiological mechanisms are similar. **Methods** Six highly trained male subjects (mean ± SD; age: 22.3 ± 3.5 yrs, height: 181.2 ± 7.1 cm and body mass: 75.6 ± 3.8 kg) performed, in a rowing ergometer (Concept II, Model D, CTS, Inc.), two experiments: (1) a square wave transition exercise from rest to VO<sub>2</sub>max intensity until exhaustion, determined 24-48h before through an incremental protocol, and (2) a 2000m all-out exercise. Gas exchange parameters were assessed breath by breath (averaged 5s) using a portable and telemetric gas analyser (K4b2, Cosmed, Italy) and their peak values assessed during the last 60s of exercise. Capillary blood samples for peak blood lactate concentrations ([La]<sub>peak</sub>) analysis were collected from the earlobe at 3 and 5 min after exercise. VO<sub>2</sub> kinetic responses were

modelled using a double exponential model  $[VO_2(t)=A_0+A_1(1-\exp(-t-TD_1/\tau_1))+A_2(1-\exp(-t-TD_2/\tau_2))]$ . Results The following mean ( $\pm$ SD) values for VO<sub>2</sub>max vs 2000m tests were similar: HR<sub>peak</sub> (179.1 $\pm$ 15.1 and 181.7 $\pm$ 11.3 bpm), A<sub>1</sub> (40.6 $\pm$ 3.7 and 44.9 $\pm$ 5.1 ml.kg<sup>-1</sup>.min<sup>-1</sup>),  $\tau_1$  (11.6 $\pm$ 3.2 and 11.6 $\pm$ 2.1 s), A<sub>2</sub> (3.6 $\pm$ 1.3 and 3.9 $\pm$ 0.9 ml.kg<sup>-1</sup>.min<sup>-1</sup>) and  $\tau_2$  (28.7 $\pm$ 10.2 and 26.1 $\pm$ 6.9 s). Although of the same order of magnitude, differences between tests were found ( $p < 0.05$ ): time (215.2 $\pm$ 30 and 391.3 $\pm$ 4.1 s), power (398.3 $\pm$ 9.9 and 372.7 $\pm$ 11.7 W), VO<sub>2</sub>peak (65.7 $\pm$ 2.2 and 69.1 $\pm$ 1.2 ml.kg<sup>-1</sup>.min<sup>-1</sup>), [La]<sub>peak</sub> (10.2 $\pm$ 1.1 and 13.8 $\pm$ 1.4 mmol.l<sup>-1</sup>), TD<sub>1</sub> (6.6 $\pm$ 2.1 and 11.7 $\pm$ 1.2 s) and TD<sub>2</sub> (66.7 $\pm$ 12.8 and 107.6 $\pm$ 13.9 s). Discussion Results indicate that the VO<sub>2</sub> kinetics is similar in-between tests, with the exception of some ventilatory and metabolic differences. Data suggest that the VO<sub>2</sub> steady-state phase occurs at the same rate and with the same amplitude following a step increase in ATP turnover, in both fast and slow phases, irrespective of the intensity performed in both tests. Therefore, the VO<sub>2</sub>max intensity can be used as an effective training stimulus for the 2000m race in highly trained male subjects. References Ingham SA, Pringle J, Hardman S, Fudge B, Richmond V. (2013). *Int J Sports Physiol Perform*, 8, 123-129. Mello S, Bertuzzi R, Grangeiro P, Franchini E. (2009). *Eur J Applied Physiol*, 107, 615-619. Contact sousa.acm@gmail.com

### VALIDITY OF THE DETERMINATION OF ENERGY COSTS DURING A SOCCER SPECIFIC INTERMITTENT SHUTTLE RUN TEST BY MEANS OF METABOLIC POWER CALCULATION - A PILOT STUDY

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Introduction: The metabolic demands of soccer and other team sport players during matches have been widely studied during the last years. There is no data for energy expenditure during official matches. A new mathematical calculation can be used to estimate instantaneous metabolic loads during a match. Using this method, it may be possible to calculate the energy costs by velocity and acceleration data, measured by global positioning system technology (GPS). The aim of this study was to validate this new approach for the assessment of metabolic demands from GPS data against direct measurements with spirometry (SM) during the Loughborough intermittent shuttle test (LIST) which reflects the physiological and metabolic demands during intermittent high-intensity exercise, like in team sports. Methods: 8 healthy male sport students agreed to participate (25.5 $\pm$ 5.9 y, 179.8 $\pm$ 3.4 cm, 76.0 $\pm$ 7.1 kg). Subjects performed the LIST with 5 sections of 15 min, split by 3 min breaks, followed by one section to exhaustion. Each section consists of 10-12 repetitions of a 20m shuttle with different velocities (5.5 km/h, maximal sprints, 55% and 95% of maximal speed). Simultaneously, GPS and SM data were recorded for comparing direct vs. indirect measurement of energy costs (EC). Accelerations and decelerations were calculated from the velocity, monitored by a portable GPS system (5 Hz). Data were analyzed by means of a paired t-test and Pearson's chi-squared test. Results: Energy costs were significantly higher in SM measurements compared to the calculated energy costs (11.24  $\pm$  0.96 kcal/kg vs. 12.68  $\pm$  2.00 kcal/kg, 2p < .05 for calculated vs. directly measured values). The correlation between the calculated EC from GPS data and SM were highly significant in the exhaustion section ( $r = 0.96$ , 2p < .01) and significant in the total test ( $r = 0.77$ , 2p < .05). Discussion: The data confirms that the determination of EC during the LIST from GPS seems to be possible and valid, however, the results underestimate the real energy costs. This pilot study is a first approach for the analysis of the validity of the formula for the calculation of the EC in official soccer and other team sport matches. Further validity studies comparing direct and indirect measurements of energy expenditure during matches are necessary before using the formula for detailed analysis. Also further study is needed which includes different factors that can not be measured by GPS like passing and shooting. References: di Prampero, P. E., Fusi, S., Sepulcri, L., Morin, J. B., Belli, A. & Antonutto, G. (2005). Sprint running: a new energetic approach. *The Journal of Experimental Biology*, 208, 2809-2816. Contact: jan.venzke@rub.de

### EFFECTS OF 8 - WEEK HIGH INTENSITY INTERVAL TRAINING ON ANAEROBIC AND AEROBIC CAPACITY IN TAEKWON-DO ITF ATHLETES

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INTRODUCTION Repeated maximal actions (punching or kicking) may result in extremely high muscle lactate concentrations thus in an effort to enhance anaerobic power and capacity, combat sports athletes may perform high intensity interval training (HIT). Much of this form of training aims to improve anaerobic function, particularly glycogenolysis, but aerobic contributions and adaptations are also involved. The aim of this study was to investigate the effects of eight weeks of specific high intensity interval training on the anaerobic and aerobic capacity in Taekwon-do ITF athletes. METHODS To test the hypothesis that HIT improve both aerobic and anaerobic performance a pre- to postintervention training study was executed. Each subject in our study completed Wingate test (WAnT) and incremental VO<sub>2</sub>max treadmill test before and after the 8 - week of training program. Thereafter, fighters were randomly allocated into interval training group (HIIT, n = 10) and control group (CON, n = 10). Subjects of HIIT group during 8 week intervention, 2 times per week (at least 48 hours rest between training sessions), participated in 30 - s maximum efforts interspersed with 90 - s rest. RESULTS The HIIT group is characterized by significantly increase in anaerobic peak power, total work done, time of maximal power maintenance and increase in lactate plasma values during Wingate. In HIT group we reported significant increase in VO<sub>2</sub>max during treadmill incremental test. The HIIT group also was characterized by lower oxygen uptake and minute ventilation during running with submaximal speed. In control group results did not differ between pre and post training period. DISCUSSION Previous research has shown that HIT is an effective training method for improving buffering capacity, anaerobic power, VO<sub>2</sub>max and delaying time of fatigue during long - endurance type exercises (MacDougall 1998 , Creer 2004, Burgomaster 2005). The Wingate test have shown that in HIT group was an increase in peak power (PP), phase of power maintenance (MP), total work done (W) and higher plasma lactate values which indicates improved anaerobic capacity. The higher VO<sub>2</sub>max during treadmill incremental test and lower oxygen uptake and minute ventilation during running with submaximal speeds after HIT training shows improved aerobic metabolism and better economy of work (exercise). REFERENCES: Burgomaster KA, Hughes SC, Heigenhauser GJ, Bradwell SN, Gibala MJ (2005) Six sessions of sprint interval training increases muscle oxidative potential and cycle endurance capacity in humans. *J Appl Physiol Jun*;98(6):1985-90. Epub 2005 Feb 10. Creer AR, Ricard MD, Conlee RK, Hoyt GL, Parcell AC (2004) Neural, metabolic, and performance adaptations to four weeks of high intensity sprint-interval training in trained cyclists. *Int J Sports Med Feb*;25(2):92-8. MacDougall JD, Hicks AL, MacDonald JR, McKelvie RS, Green HJ, Smith KM (1998) Muscle performance and enzymatic adaptations to sprint interval training. *J Appl Physiol Jun*;84(6):2138-42



## DETERMINATION OF ENERGY COSTS DURING TWO-DIRECTIONAL MULTI-STAGE SHUTTLE RUNNING USING A NOVEL CALCULATION – A PILOT STUDY

Kirmse, M., Venzke, J., Praetorius, A., Platen, P.  
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Introduction: The physiological demands imposed on soccer and other team sport players during official matches and training sessions has been the subject of research since many years, but most available methods are not able to estimate instantaneous metabolic loads during a match. Recently, a mathematical method for the determination of energy costs (EC) during soccer matches using velocity and acceleration data has been described<sup>1</sup>. This method, however, has not been validated against direct measurements of EC during controlled running so far. The aim of this study is to analyze the validity of the mathematical calculation of EC from velocity and acceleration data against direct measurements of EC with spirometry during two-directional shuttle running with different shuttle lengths. Methods: 8 healthy sport students agreed to participate (w:n=3, m:n=5, 25.1±2.5y, 178.7±6.1cm, 68.8±12.9kg). Subjects performed 3 separate shuttle run tests to exhaustion with a shuttle length of 10m(n=7), 20m(n=7), and 30m(n=6), respectively (start with 8 km/h, increase of 0.5 km/h per min, randomized order). Each test was performed with spirometry for the direct determination of EC. Accelerations and decelerations were analyzed from GPS-monitored velocities (5 Hz) and data were entered into the formula<sup>1</sup> to get calculated EC. Results: Total EC of shuttle running varied broadly between subjects due to the large variation in aerobic performance. Total EC increased with increasing shuttle length from 10m to 30m. Calculated EC from GPS data resulted in 10% to 30% lower values compared to directly measured EC (10m: 81.8±29.7 kcal vs. 107.0±39.3 kcal; 20m: 136.1±49.2 kcal vs. 151.2±55.0 kcal; 30m: 144.8±54.7 kcal vs. 175.4±77.9 kcal, 2p<0.05 for calculated vs. directly measured values, respectively). Correlations between GPS-determined and spirometry-determined EC data were highly significant in all three shuttle distances (10m: r=0.96; 20m: r=0.86; 30m: r=1.0, 2p<0.05). Discussion: Determination of EC during multi-stage shuttle running from GPS velocity and acceleration data by means of mathematical calculation is possible and seems to be valid, however results in 10% to 30% underestimation of real EC. Further validity studies comparing direct measurements of EC with formula-derived values using defined run distances, velocities and run directions, including indirect and direct determination of EC during soccer and other team sport test matches is necessary before using the formula for detailed metabolic analysis in real matches. References: <sup>1</sup>Di Prampero PE et al. Sprint running: a new energetic approach. *J Exp Biol* 208, 2809 (2005). Contact: marius.kirmse@rub.de

## Mini-Orals

### MO-SH06 Philosophy & Ethics

#### ETHICAL VALUE OF ORIENTAL MARTIAL ARTS

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Introduction Oriental martial arts have the distinct value of enabling the practitioner to transcend from physical motion to the introspective self-examination and train the spirit (Cua, 1998; Eui, 2000). The use of oriental martial arts training to foster modern humanistic education, morals and ethics is a very interesting tool that has drawn much attention lately (Cho, 2011). The purpose of this study is to investigate the ethical value and implementation of practical ethics as a result of participating in oriental martial arts. By examining these ethical aspects suggestions for ethical standards can be developed. Methods A literature review focusing on the concepts, history, philosophy, and ethics of Oriental martial arts was carried out. Results First, the ethics of oriental martial arts involves both the mental and physical understanding of our daily habits. For epistemic comprehension of orientation martial arts it is vital for our bodies to be perfectly familiar with the somatic learning of ethics. Second, one may achieve virtue through somatic learning and the increase in their mental capability. Third, if one can attain the both epistemic comprehension and somatic learning then one will be able to behave ethically correct in every situation and recognize the values of such behaviour. Discussion To signify the practical value of oriental martial arts ethics we focus on epistemic comprehension and somatic learning. It is possible to foster enlightenment via martial arts in epistemic meaning, a comprehension stage, and it is also possible to achieve virtue in somatic meaning, a learning stage. Natural somatic expression appears through the realization of the mind in the learning process of epistemology. Ways to foster virtue by the ethical ideals of Confucius, Mencius and Xunzi in Xianqin Rujia and Laozi in Taoism are also discussed. This study also draws comparison between the oriental acquisition of enlightenment and Aristotle's practical wisdom considering practical actions in detail. One of the commonalities of Confucius, Mencius, Hsuntzu and Aristotle's is the necessity to learn without the exception of practical ethics. References Cua A. (1998) Basic Concepts of Confucian Ethics in Moral Vision and Tradition. Washington D.C Catholic University of America Press, 267-302. Eui J.C. (2000). The Journal of Korean Alliance of Martial Arts, 2, 22-28. Cho SK. (2011). Journal of Korean Philosophic Society for Sport and Dance, Vol 19(4), 1-11 Contact [ohree60@pusan.ac.kr]

#### COMPARATIVE STUDIES ON THE SPORTSMANSHIP AND SWORDSMANSHIP

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Introduction Since the swordsmanship has enjoyed a long history in China since the ancient times, it is said that swordsman is the idol of all the Chinese people. And the swordsman movies and martial arts fictions are still the most popular elements in the Chinese culture today. In reality, various sports events such as the Olympic Games are also in their full swing. However, at the same time, the literary works with sports as the main topic are rather few. Why it is hard for the eye-catching sports in the reality to be favored by the writers and film directors? The research will focus on the originality of the swordsmanship and sportsmanship as well as their differences and associations. As far as the author is concerned, it is beneficial to emphasize the swordsmanship advocated in the ancient times as the therapeutic means for self-interest and dishonest—the two malignant tumors in the sports circle—which are getting epidemic nowadays to reflect the relativity of the sportsmanship. Methods The research methods such as literature review and logical analysis will be adopted in the research. Conclusions Sportsmanship is generally regarded as the sign of the modern civilization and swordsmanship can manifest the ideal of people as well as the pursuit of people for freedom and equality in the films and literature. Compared with swordsmanship, sportsmanship, the so-called product of the compromise to the reality, is the game rules in the human society, representing the progress

of the society ruled by law. Discussions Originality of swordsmanship: Swordsmanship boasted to be the outcome of the hope and the swordsmen became the embodiment of the "absolute justice". (Chen Ping yuan: Dream of Swordsmanship since the Ancient Times—Studies on the Genre of Martial Arts Novels). In short, swordsmanship was a reflection of the dream of the people of equality, freedom and justice in the chaotic times. Relativity of swordsmanship: In the chaotic days, people admired swordsmen but few wanted to be one of them. Originality of sportsmanship: Based on the theory of school of psychology, people are aggressive in nature subconsciously. "The pugnacity of the human being, also called the invasiveness, as a really basic instinct of unconsciousness, has its own release mechanism. Like lust and other basic instincts of human being, it would arouse peculiar but rather intense euphoria. Relativity of sportsmanship: Sportsmanship is quite similar to a kind of social contract under some occasions. As a matter of fact, the uninhibited individuality, the sentiment of justice and the heroism of the swordsman signify the vitality and passion of life. Besides, in the secular society where people are restrained by the rules created by themselves and are busy with making a living and trifles, it is a reflection of the people who are eager for freedom and equality. References 1. Chen Ping yuan: Dream of Swordsmanship since the Ancient Times—Studies on the Genre of Martial Arts Novels. People's Literature Publishing House. March 1992, Edition 1,1-2

## RESEARCH REGARDING THE OCCURRENCE OF NEW ELEMENTS FOR VAULTING TABLE PERFORMANCE IN MEN'S ARTISTIC GYMNASTICS

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Introduction More recently a total of 800 elements have been recorded in the Gymnastics Code of Points. However there are few theses on elements of gymnastics history. As such we wonder by whom, when or where these various elements are performed. The purpose of this study was to collate data elements on the Vaulting Table (VT) in men's artistic gymnastics and to suggest new elements in the future. Methods The method of study was undertaken by bibliographic analysis. This article refers mainly to journals that were published by the Japan Gymnastic Association, and a list that was made regarding the occurrence of new elements on VT in men's artistic gymnastics. Results From the analysis, the author gathered data regarding various elements that were performed. For example, Handspring sideward with 1/4 turn and salto backward tucked (Tsukahara) was performed by TSUKAHARA.M in the 1969 Japan National competition. Hand-spring sideward with 1/4 turn and salto forward tucked with 1/2 turn (Kasamatsu) was performed by KASAMATSU.S in the 1974 World Championships. The Kasamatsu stretch with a full twist was performed by AKOPIAN.A in the 1981 World Championships. Another example, Handspring forward with 1/2 turn and salto backward tucked (Cuervo) was performed by CUERVO.J in the 1973 Universiade in Moscow. Additionally, in recent years, the round off, handspring backward and salto backward stretched with triple twist was performed by SHIRAI.K and KIM.H.H in the 2013 World Championships. Discussion In conclusion, developments of VT elements are greatly influenced by the improvement of apparatus, rules of the era and improved skills of men's gymnastics. As a result, we have to pay attention to changes to the Men's Code of Points and the improvement of apparatus. In the near future, directions of new occurring elements on the VT may add twists to the existing elements. References Tagawa, T. (1982). Japan gymnastics association Study of information, 50 59-81. Tuchiya, J. Katase, F. and Akaba, A. (2002). Japan gymnastics association Study of information, 88, 8-9. Contact My email address nakasone@bss.ac.jp

## KUNG FU CANTON: CULTURE OF MARTIAL ARTS IN GUANGDONG, CHINA

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Introduction "Canton" original meaning was capital in English. At the time Guangzhou was the capital of Guangdong and Guangxi regions, therefore was later named 'Canton' by foreigners. In modern era, Canton gradually refers to China Guangdong region. Kung fu is a Chinese term referring to any study, learning or practice that requires patience, energy, and time to complete, often used in the West to refer to Chinese martial arts, also known as Wu Shu. Methods literature research was conducted using Guangdong library and Guangdong national archive computerized database back to 1900. The primary free-text terms entered were "Wu Shu," "Kung Fu," "culture of Lingnan Kung Fu." Various relevant articles and documents were selected in abundant traditional culture fields that included physical activity, art, medicine and architecture. Field research also be used in this study to gain an intimate perspective of Kung fu culture within Guangdong area. Multiple sources of information were obtained by participant observation in local martial club, TCM clinics and historical sites. Results This study shows that Chinese Kung fu plays an integral part into shaping cultural, artistic and medicinal landscape in southern China. Indeed cultural events such as opera and lion dance draw their inspiration from Kung fu. Kung fu movement and terms are also transposed to Chinese traditional medicine because of the deep understanding of human body and meridians it requires. Because Kung fu draws from social and historical sources, it never stops evolving while still remaining deeply anchored in Chinese cultural heritage. We can conclude that Kung fu is a sustainable martial art and in many aspects a valuable and healthy way of life. Discussion Kung fu is a word borrowed from the Chinese word gongfu, which translates as accomplished or cultivated skill. Wu Shu would be a more accurate word to have borrowed, but it's still just an umbrella term for a whole myriad of Chinese martial art, ranging from drunken boxing to the Fujian white crane. Perhaps the most famous style in Guangdong is Wing Chun, which was taken by the now legendary Ip Man to Hong Kong, from where it spread out across the world via Hong Kong Kung fu flicks. Religion beliefs, traditional moral, legend of Kung Fu hero, even Lingnan architectural style and Hong Kong Kung Fu film, multiple elements contribute to the unique culture of Guangdong martial art. References Yang, Jwing-Ming. (1989). The root of Chinese Chi kung: the secrets of Chi kung training. Yang's Martial Arts Association. ISBN 0-940871-07-6. 2 Aung, S.K.H. & Chen, W.P.D. (2007). Clinical introduction to medical acupuncture. Thieme Medical Publishers. ISBN 978-1-58890-221-4 Abstract Model Contact helene@gzhu.edu.cn

## Mini-Orals

### MO-SH05 Psychology II

#### DEVELOPMENT OF THE CHINESE VERSION OF THE SPORT MOTIVATION SCALE-II: A PILOT STUDY

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Self-Determination Theory (SDT; Deci & Ryan, 1985) has been popularly used for studying athlete motivation. The Sport Motivation Scale-II (SMS-II; Pelletier, Rocchi, Vallerand, Deci, & Ryan, 2013) is a SDT-based multidimensional scale recently developed to measure athlete motivation. This pilot study was to develop the Chinese version of the SMS-II. The SMS-II was translated into Chinese language by two bilingual sport psychologists. Chinese university athletes (N = 223) participating in a variety of sports were recruited. The results showed that the scale had adequate internal reliability ( $\alpha = .70$  to  $.78$ ). The factorial validity of the scale was generally adequate based on the findings of confirmatory factor analysis. Future research on the Chinese version of the SMS-II was discussed.

#### PARTICIPANT MOTIVATION: A COMPARISON ACROSS WORLD MASTERS INTERNATIONAL COMPETITIONS

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Do not insert authors here Introduction Motivation is defined as "the directions and intensity of one's effort" and is important in the selection of sport. Participant motivation evaluates factors that enhance or inhibit motivation to participate (Marcus & Forsyth, 2009). Some research has been conducted on masters athletes at the level of individual competitions, however comparisons between competitions is rare (Heazlewood et al., 2011; Heazlewood et al., 2012). The research aim was to compare participant motivation of athletes across three international masters' competitions, 2009 World Masters Games (WMG), 2010 Pacific Masters Games (Pan Pac) and 2010 Golden Oldies Rugby Festival (GORF) develop sport psychological strategies to enhance participation in these international competitions. Methods Athletes volunteered and were from WMG, Pan Pac and GORF. The athletes completed the 56 item Motivations of Marathoners Scale (MOMS), using a 7-point Likert scale. The nine factors were health orientation, weight concern, personal goal achievement, competition, recognition, affiliation, psychological coping, life meaning and self-esteem (Masters et al., 1993; Ogles, et al., 2000). Results Predominant factors for cohorts were, WMG goal achievement, health orientation and affiliation; Pan Pac affiliation, health orientation and goal achievement; and GORF affiliation, health orientation, psychological coping and goal achievement. Factors of self-esteem and weight control of moderate importance and recognition, life meaning and competition of low importance with all cohorts. Psychological coping of low importance with WMG and Pan Pac athletes. Discussion All cohorts identified factors of health orientation and affiliation as important. Goal achievement was more important to WMG and Pan Pac athletes than for GORF who identified psychological coping as moderately important. These data highlight the participant motivation factors motivating athletes to compete and will enable the articulation of marketing strategies with the participant motivation needs of these international athletes. References Heazlewood I, Walsh J, Climstein M, Burke S, Kuttunen J, Adams K, DeBeliso M. (2011). World Academy of Sci, Eng and Tech. 77, 2027-2032. Heazlewood I, Walsh J, Climstein M, DeBeliso M, Adams K, Burke S, Kettunen J. (2012). ICSEMIS 2012 Pre-Olympic Conference. 19-24 July 2012 Glasgow, UK. Marcus B, Forsyth L. (2009). Motivating People to be Physically Active. Human Kinetics, Lower Mitcham. Masters KS, Ogles BM, Jolton JA. (1993). Res. Quarterly for Exerc. & Sport. 64(2), 134-143. Ogles B, Masters KS. (2000). J. Sport Beh. 23(3), 1-14. Contact Ian.heazlewood@cdu.edu.au

#### PSYCHOPHYSIOLOGICAL AROUSAL, INDIVIDUAL DIFFERENCES AND PERFORMANCE IN ATHLETES

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Introduction Arousal, is a degree of increase in bodily activation presenting with hormonal changes and other physiological variances related to thoughts and feelings (Zaichkowsky and Naylor 2004). Factors evoking stress reactions affect a person's arousal level. The regulation of arousal level in sports is important in regard to performance. This study aimed to investigate the possible effects of personality and emotional intelligence (EI) on the association between arousal and performance. Methods Schutte Emotional Intelligence Scale and short form Five Factors Personality Inventory were completed by 58 elite athletes. The maximal voluntary contraction (MVC) and strength of the athlete's triceps surae muscle was recorded with surface electromyography (EMG) and force sensor respectively. These parameters were continuously recorded during stages in which athletes were subjected to negative visual stimuli, and performed a cognitive task. In each stage the three measurements were carried out with two minute breaks in between. In all stages autonomic nervous system reactions were evaluated with skin conductance response (SCR). A portable biopotential amplifier was used for recording. Results MVC and strength levels increased during negative visual stimulation, and decreased during the cognitive task. Athletes with high openness scores experienced a lower decrease in performance during cognitive tasks. There was a positive correlation between extroversion scores and SCR during negative visual stimulation. Discussion Results imply that performance varies in different levels of arousal, and arousal level and performance may be related to some individual characteristics. The increase in athlete's MVC and strength during the presentation of negative pictures, and their decrease during cognitive tasks supports the Inverted U hypothesis (Yerkes and Dodson, 1908). The lower decrease in performance observed in those with high openness implies that performance in these individuals may be less affected by challenging conditions. This finding may be related to greater use of avoidance coping strategies in athletes with lower openness to experience (Allen et al 2011). Eysenck (1967) reports stimulus seeking in extroverts due to lower cortical arousal levels. Therefore extroverts may be said to be more prone to arousal and may have been more aroused during visual stimulation. References Allen MS, Greenlees I, Jones M. (2011). An investigation of the five-factor model of personality and coping behaviour in sport. Journal of Sports Sciences, 29(8):841-850. Eysenck HJ. (1967) The Biological Basis of Personality. Springfield, IL: Thomas. Yerkes RM, Dodson JD (1908) The relation of strength of stimulus to rapidity of habit-formation. Journal of Comparative Neurology and Psychology, 18:459-482 Zaichkowsky LD, Naylor AH. (2004) Arousal in Sport, In. Spielberger C. D., Encyclopedia of Applied Psychology, Oxford: Akademi, third edition edited by C. D. Spielberger, p.155-163, (e-book). Contact gamze.ungur@deu.edu.tr

### TO BE IN THE ZONE - MEASUREMENT OF STRESS LEVEL WITH EGIG THROUGH ELITE MX ATHLETES

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**Introduction** According to Hanin's theory every people have their own individual zones of optimal functioning. A new innovation called electro-gastro-intestinograph (EGIG) is able to measure gastric and intestinal motility on a non-invasive way. This EGIG could surpass the paper and pencil testing as it provides objective numeric data of anxiety. This study is the first step of examining the anxiety level of A-level motocross (MX) athletes. **Methods** 3 MX athletes whose age is 18 (sd=3,5) and 4 non-athletic regular people (NARP) whose age is 24 (sd=2,4) took part in the examination. The applied EGIG has a Hungarian patent and developed by the EXPERIMETRIA Ltd. The gastric and intestinal motility and its response to a single sound stimulus was monitored. Each monitoring took 40 minutes on empty stomach with a sound stimulus exactly at 20 minutes. The unit of the measured data is cycles per minute (CPM). **Results** The greatest variance was measured on the large intestine. The MX athletes' resting average was 5,22 CPM (sd=1,14) which is higher than the NARP's 2,47 CPM (sd=0,55). However the maximal value followed by the sound stimulus was 10 CPM (sd=1,1) of the MX athletes which is 191% of their resting average. The NARP maximal value was 8,33 CPM (sd=1,77) which is 304% of their resting average. The resting average of the two groups are fairly close. The MX athletes' resting average was 4,81 CPM (sd=0,47) and the NARP's was 4,6 CPM (sd=1,07). The athletes resting average was 92% of their resting average and the NARP's was 167% of their resting average;  $t(6) = -5,819$ ;  $p=0,002$ . **Conclusion** The higher resting CPM of a MX athlete can explain a prepared status to an unknown event. This is confirmed by the athletes' lower maximal CPM in proportion to their resting averages, and by the close resting average of the athletes and NARP. According to my results the examined MX athletes have lower stress level than the NARP. I would confirm these results by further studies.

### HYPERTHERMIA-INDUCED ALTERATION IN COMPLEX COGNITIVE TASK PERFORMANCE IS REVERSED BY 11 DAYS OF HEAT ACCLIMATION

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**Introduction:** Major sporting events are organised during summer months where environmental conditions can be extreme. Consequently, the International Olympic Committee has highlighted the need and importance to heat acclimate. The physiological responses to acclimation are well investigated and occur approximately within one to two weeks, allowing to improve the physical work capacity in hot environments. However, despite a deleterious effect of hyperthermia on complex cognitive tasks in unacclimated athletes, it remains unknown if heat acclimation can improve cognitive functions in hot environments. **Aim:** The aim of this study was to investigate if acclimation had a protective effect on cognitive functions. **Methods:** 9 male subjects (37.0±8.9 years; 176.3±8.6cm and 72.0±8.1kg) voluntarily participated to the study. Subjects performed a simple (OTS-4) and complex (OTS-6) planning task (OTS: One Touch Stocking of Cambridge) under hot (HOT: 46–48°C) and control (CON: 24°C) conditions in a counterbalanced order, both before and after 11 days of passive heat acclimation (1h a day of heat exposure). Subjective measures of thermal comfort (TC) and thermal sensation (TS) were recorded in each condition. Core (T<sub>core</sub>) and skin surface (T<sub>skin</sub>) temperatures were recorded throughout the cognitive test by a rectal probe and 4 surface thermistors. **Results:** HOT test were performed at a T<sub>core</sub> clamped at 39°C. Consequently, T<sub>core</sub>, T<sub>skin</sub>, TS and TC were similar before and after acclimation ( $p>0.05$ ) but significantly higher in HOT compared to CON ( $p<0.05$ ). Cognitive performance during the simple task (OTS-4) was not affected by hyperthermia. Cognitive performance during the complex task (OTS-6) was altered by hyperthermia before ( $p=0.016$ ) but not after ( $p=0.397$ ) heat acclimation. This was due to a significant improvement of the performance in HOT ( $p<0.001$ ) but not CON ( $p=1.000$ ) following acclimation. **Conclusion:** One hour of passive heat exposure daily for 11 days allows protecting complex cognitive task performance in hot environments. The mechanisms behind this protective effect are still unclear.

### ACUTE PHYSICAL EXERCISE PERFORMED IN HYPOXIC CONDITIONS IMPROVES EXECUTIVE FUNCTIONS

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**Introduction** The body's acute and chronic responses to the effects of hypoxia can alter physiological and brain functions due to decreased O<sub>2</sub> intake. However, the effect of acute exercise in hypoxic conditions on executive functions has never been evaluated. The aim of this study was to evaluate the influence of acute physical exercise under hypoxic conditions on executive functions. **Methods** The participants of this study were 38 healthy men, distributed randomly into 4 groups (Normoxia n=10, Hypoxia n=10, Exercise in Normoxia n=10 and Exercise in Hypoxia n=10), aged 23 ± 8 years, with a weight of 71 ± 7 kg, height of 1.76 ± 1 m, BMI of 22 ± 9 kg/m<sup>2</sup> and VO<sub>2</sub> peak of 47 ± 4.2 ml/kg/min. The executive function was evaluated using the Random Number Generation Test (Towse et al., 1998), which was applied on the first day in all groups and reapplied on the second day, immediately after the exercise session of 60 minutes at 50% of peak VO<sub>2</sub>. The hypoxia and exercise in hypoxia groups were exposed to hypoxic conditions equivalent to 4500-m for 29 hours (Colorado Altitude Training™/12 CAT-Air Unit). Two-way ANOVA was used to determine differences between the groups. The statistical significance was determined as  $p<0.05$ . **Results** There was a significant improvement in executive functions ( $p = 0.001$ ) in the exercise in hypoxia group when compared with the hypoxia group. In the hypoxia group a significant worsening in executive functions was observed ( $p=0.003$ ), compared with the normoxia group. The normoxia and exercise in normoxia groups did not differ significantly. **Discussion** These results suggest that acute physical exercise performed in hypoxic conditions can improve executive functions. This may occur due to the effect of exercise on improving blood viscosity (Conti et al., 2013), thus improving executive functions. However, more studies are necessary for a better understanding of the mechanisms involved. **References** Conti AA, Macchi C. (2013). Clin Ter, 164(4), 293-4. Towse JN, Neil D. (1998). Behavior Research Methods, Instruments, & Computers, 30, 583–591. Supported by FAPESP n ° 2012 / 09236-4 Contact tmello@demello.net.br

## THE EFFECT OF MANIPULATING EXERCISE INTENSITY AND SPEED - ACCURACY INSTRUCTIONS ON COGNITIVE PERFORMANCE

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**INTRODUCTION** Exercise has been identified as a strategy to promote cognitive maintenance in advanced age. The manipulation of dose-response components during acute bouts of exercise will help elucidate this complex relationship. Exercise intensity is a key modifiable parameter in this relationship. A meta-analysis by Chang and et al., (2012) suggested that various exercise intensities conferred different post exercise cognitive effects. Also, older adults reportedly experience stereotype inflated age related deficits in reaction time (RT) (Mazerolle et al., 2012) which may influence strategy selection on speeded RT tasks (Joyce et al., 2014), with strategies being more cautious with performance characterised by slower RT and high levels of accuracy. The effect of such strategies on performance during different exercise intensities should be investigated. **METHODS** Thirty - two participants (16 young: 20 ± 3 years; 16 old: 64 ± 2 years) completed the study which aimed to investigate the impact of different intensities of exercise (light & moderate) on RT and cognitive control as measured by the Simon task during exercise (30 minutes of cycling at either 50-55 % age predicted maximal heart rate (HRmax) or 65 % HRmax) and for 25 minutes post exercise. Use of RT distributional analysis allowed for the accurate examination of conflict resolution mechanisms and how these were affected by the speed or accuracy instructions. **RESULTS** Results confirmed an age - associated deterioration in processing speed (420ms vs 360ms) ( $p < 0.001$ ), while highlighting an equivalent cognitive control for older and younger adults (30ms vs 28ms,  $p = 0.57$ ). The hypothesised benefit of exercise on RT was not observed in this study ( $p = 0.26$ ) but the manipulation of speed-accuracy instructions had a considerable effect on performance, resulting in reduced RTs and accuracy levels for speed ( $p < 0.001$ ) as compared to accuracy directives for both age groups. **DISCUSSION** Results showed that under favourable conditions older adults can appreciably reduce the magnitude of the typical age - related deterioration in processing speed. The design complexity of the study may have precluded an exercise-induced facilitation which has previously been reported in the literature. Future studies should focus on manipulating moderator variables in isolation to better disentangle their contribution to improved performance. **REFERENCES** Chang et al (2012) Brain Res, 1453, 87-101. Joyce et al (2012) Med Sci Sports Exerc, 46(3), 630-639. Mazerolle et al (2012) Psych Sci, 23(7), 723-727. **CONTACT** Dr Jennifer Joyce: j.joyce@worc.ac.uk

## Mini-Orals

### MO-PM08 Adapted physical activity: Disabilities

#### EFFECTS OF STRENUOUS EXERCISE ON SALIVARY HUMAN NEUTROPHIL PEPTIDES 1-3 AND BLOOD NEUTROPHILS IN YOUNG MALE SUBJECTS

Hanaoka, Y.1, Shimizu, K.2, Oikawa, S.1, Kimura, F.1, Sone, R.1, Watanabe, K.1, Akama, T.3, Kono, I.1, Miyamoto, T.1

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**Introduction** In the field of athletics, the risk of upper respiratory tract infection (URTI) is one of the most important problems in athletes. Salivary human neutrophil peptides 1-3 (HNPI-3) have anti-virus activity, thereby preventing URTI. HNPI-3 are predominantly expressed in neutrophils. There is only one report about HNPI-3 in response to exercise. However, this response did not examine immediately after exercise. The aim of this study was to examine salivary HNPI-3 and neutrophils responses to strenuous exercise until 24 hours after exercise. **Methods** 8 healthy young male subjects (23.4 ± 0.6 years) participated in this study. The subjects performed exercise experiment (exercise on a cycle ergometer at 75% VO<sub>2</sub>max for 60 min). Saliva and blood samples were collected pre exercise (7:30 A.M.), post exercise (8:30), post 1 h (9:30), post 2 h (10:30), post 3 h (11:30), and post 24 h (next 8:30 A.M) after the bout of exercise. HNPI-3 concentrations were measured by the enzyme-linked immunosorbent assay. Counts of neutrophils were obtained using an automated cell counter. The visual analogue scale for subjective fatigue was used at the same points as sample collections. **Results** Mean salivary HNPI-3 concentration at pre, post, post 1h, post 2h, post 3h and post 24h were 36.2 ± 8.9, 60.6 ± 14.4, 38.0 ± 7.4, 27.9 ± 6.1, 36.3 ± 7.8, 35.3 ± 12.9 ng/ml respectively. Salivary HNPI-3 concentration changed in this study (effect size:  $\eta^2 = 0.128$ ;  $p = 0.312$ ). Mean absolute number of blood neutrophils was at pre, post, post 1h, post 2h, post 3h and post 24h were 4088.4 ± 651.8, 4915.5 ± 932.8, 6127.0 ± 976.1, 7140.3 ± 1120.3, 6984.2 ± 1079.3, 3133.5 ± 350.0 cells/μl respectively. Blood neutrophils significantly changed in this study (effect size:  $\eta^2 = 0.285$ ,  $p < 0.05$ ). Subjective fatigue significantly increased at post exercise compared with pre exercise (effect size:  $\eta^2 = 0.501$ ,  $p < 0.01$ ). **Discussion** In this study, HNPI-3 temporarily increased after exercise and immediately returning to a baseline value at post 1h, whereas neutrophils gradually increased after the exercise and maximized at post 2h. Therefore, there might be the time lag between increased HNPI-3 and neutrophils responses to strenuous exercise. **Reference** Davison G, Allgrove J, Gleeson M.(2009) . Eur J Appl Physiol. 106(2): 277-284.

#### INSTRUMENTAL ANALYSIS AS A SUPPORT FOR THE EVALUATION SCALES USED IN GAIT ANALYSIS

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**INTRODUCTION** Project Freedom (Function of research on exergames to expand opportunities for educational mobility of the elderly) is a pilot project which aimed at promoting physical activity and mobility in old age. Adapted physical activity (APA) aims to prevent disease and to counter the damage caused by the physiological decline of psychomotor function in old age. Among the elderly, in fact, activity restriction is an independent predictor of decline in physical function. To practice adapted physical activity can slow down the motor decline in old age, which is evident also in gait characteristics. Typical characteristics of gait among the elderly are: speed reduction, rotation of the foot to increase the support base and decrease in the length of the step. Therefore, the aim of this study is the correlation of gait data in older adults using two tests: the Short Physical Performance Battery (SPPB) (Guralnik et al., 1994) and G Walk. **METHODS** During this project, a study was carried out with the aim of correlating data collected on gait parameters of 16 adults between the ages of 67 and 94 years. The participants were chosen on the basis of a number of tests carried out to analyse their levels of autonomy, intellectual capacities and motor functioning. Motor skills were investigated using the Short Physical Performance Battery evaluation scale and G Walk. The former is an objective assessment tool for evaluating lower extremity functioning, in terms of static balance, gait and sit-to-stand, whereas the latter can objectively evaluate the parameters of the gait. **RESULTS AND DISCUSSION** The results show that adaptive

physical activity can have positive effects in elderly. The study opens up interesting prospects for the future, because shows that the instrumental analysis is a useful support for the evaluation scales. REFERENCES Guralnik J.M., Simonsick E.M., Ferrucci L., Glynn R.J., Berkman L.F., Blazer D.G., Scherr P.A. & Wallace R.B. (1994). A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol*;42:M85-M94. Pau M., Leban B., Collu G., Migliaccio G.M. (2014). Effect of light and vigorous physical activity on balance and gait of older adults *Arch. Gerontol. Geriatr*, Nov-Dec;59(3):568-73. CONTACT iviscione@unisa.it

### RELIABILITY AND VALIDITY OF THE CHINESE VERSION OF THE PREGNANCY PHYSICAL ACTIVITY QUESTIONNAIRE

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**Introduction** Physical activity of pregnant women tends to be of lower intensity, frequency, and duration as compared with prepregnancy levels (Hinton et al., 2001). Several researches support that it is an important part of physical activities during pregnancy to promoting health. Participation in physical activity during pregnancy may reduce the risk of gestational diabetes mellitus (Dempsey et al., 2004) and preeclampsia (Safflas et al., 2004) and help to prevent excess gestational weight gain (Skouteris et al., 2010). However, because of the lack of an appropriate measurement instrument, the physical activity status of Chinese pregnant women remains unknown. The association between physical activity during pregnancy and pregnancy-related outcomes is unclear. Therefore the aim of this study was to translate the English version of the pregnancy physical activity questionnaire into Chinese, and to examine its reliability and validity for Chinese pregnant women. **Methods** 224 pregnant women during the first, second and third trimesters of pregnancy were recruited. The participants were instructed to complete the Chinese version of the pregnancy physical activity questionnaire (PPAQ-C) first visit and to wear the uniaxial accelerometry sensor (Lifecorder; Suzuken Co. Ltd) for the 7 days. One week after the first visit, we collected the data from the uniaxial accelerometer records and the women were asked to complete the PPAQ-C again. **Results** The intraclass correlation coefficients (ICCs) used to measure reproducibility of PPAQ-C were 0.73 for total activity (light and above), 0.74 for sedentary, 0.72 for light and 0.58 for moderate and above intensity activities. It was 0.73 for "Household and Caregiving" and 0.73 for "occupational" activities. Spearman correlation coefficients (SCCs) between the PPAQ-C and accelerometry were 0.34 ( $P < 0.01$ ) for total activity (light and above), 0.32 ( $P < 0.01$ ) for light intensity. **Discussion & Conclusions** The PPAQ-C is reliable and moderately accurate for the measure of physical activity of various intensities and types among pregnant women. **References** HINTON, P. S., and C. M. OLSON. *Maternal and Child Health J.* 5:7-14, 2001. DEMPSEY, J. C., C. L. BUTLER, T. K. SORENSEN, et al. *Diabetes Res. Clin. Pract.* 66:203-215, 2004. SAFTLAS, A. F., N. LOGSDEN-SACKETT, W. WANG, R. WOOLSON, and M. B. BRACKEN. *Work, Am. J. Epidemiol.* 160: 758-765, 2004. SKOUTERIS H, HARTLEY C. L., MCCABE M, et al. *Obes Rev.* 11:757-768, 2010. Contact Email : [koumitsu@toki.waseda.jp]

### THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY, PHYSICAL FITNESS AND OVERWEIGHT AND OBESITY IN CHILDHOOD

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**Abstract Introduction:** Overweight and obesity have become a global epidemic, the main cause of obesity is considered to have a strong genetic influence but both overweight and obesity also are strongly influenced by physical activity. High prevalence of overweight, obesity and the high body fat percentage have been proven to have adverse effects on childhood and adolescent's health and contribute to many health problems later in life. **Objectives:** The purpose of this study is to gather information regarding the level of overweight, obesity and its relationship with physical activity in childhood. **Methods:** This thesis aims to review the scientific literature related with overweight and obesity, and tries to highlight its relation to physical activity with special focus on childhood. **Results:** The prevalence of overweight and obesity at childhood has grown dramatically in almost all countries independent of their economic development. One of the most important reasons in this respect is that physical activity dramatically declined and inactive behavior such as watching TV or spending time in front of the computer increased radically. At the same time nutrition habits changed dramatically with much more high caloric food available. **Conclusion** A physical active lifestyle together with balanced nutrition plays a significant role in controlling body weight and body fat in childhood. Public health and education strategies have to include these important aspects to reduce the future health burden related with overweight and obesity. **Reference** Ajzen J: The theory of planned behavior. *Organ Behav Hum Decis Process* 1991, 50(2):179-211. American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardio respiratory and muscular fitness, and flexibility in healthy adults. *Med sci sports exerc* 1998, 30(6):975-991. Atkin AJ, Gorely T, Biddle SJ, Cavill N, Foster C: Interventions to Promote Physical Activity in Young People Conducted in the Hours Immediately After School: A Systematic Review. *Int J Behav Med* 2011, 18:176. Barlow, SE "Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report," *Pediatrics*, vol. 120, supplement 4, pp. S164-S192, 2007. Vanreusel B., Malina R. M., van't Hof M. A. Development and tracking in fitness components: Leuven longitudinal study on lifestyle, fitness and health. *Int J Sports Med.* 1997 Jul; 18 Suppl3:S171-8. Email: kaderikadri798@hotmail.com

### THE ELEVATION OF SERUM IRISIN LEVEL AFTER SINGLE BOUT OF EXERCISE DOES NOT MODULATE DIET-INDUCED THERMOGENESIS IN HEALTHY YOUNG ADULTS.

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**INTRODUCTION** The effect of physical activity on diet-induced thermogenesis (DIT) is still controversial. Irisin is a new protein, known as cleaved from muscle to circulation by acute exercise, and as inducing browning of adipocytes. The aim of the study was to examine whether the changes in serum irisin level following single bout of exercise could modulate DIT. **METHODS** Nine normal-weight healthy young volunteers participated in two experiments in random order. In the exercise trial (EX), 40-min exercise on bicycle ergometer at 60% of heart rate reserve were performed on the day before the assessment of energy expenditure (EE) by indirect calorimetry. Blood concentration of irisin, glucose and insulin were measured before and after the intake of meal. Serum irisin levels were also examined before and immediately after the exercise. In the no exercise trial (NOEX), EE were assessed without previous exercise. **RESULTS** Serum irisin level was increased following exercise with borderline significance ( $P=0.054$ ). Postprandial irisin levels were higher in the EX than in the NOEX, whereas diet intake itself affected serum irisin levels in neither trial. Mean DIT as well as resting EE was not different between the trials. No differences were found in postprandial glucose and insulin levels between the trials. **DISCUSSION** We observed that the serum irisin level

was increased in response to single bout of exercise. Our result was consistent with the findings by Huh et al. and by Bostrom et al., which demonstrated acute increase in plasma irisin level after a sprint run and 10 week of endurance training, respectively. In the present study, DIT as well as resting EE was not affected by the exercise in the previous day, in spite of the prolonged elevation of serum irisin level. From this result, it does not seem that irisin modulates either DIT or resting EE. On the other hand, several reports have shown that acute exercise increased DIT and resting EE (JAMES O. HILL), and the increases were mainly due to the enhanced activity of sympathetic nervous system (M. GLEESON). Therefore, the discrepancy in the results might be explained by the difference in the intensity and modality of exercise as well as in the contents of test meal and the subjects' race. REFERENCES Pontus Bostrom. (2012). Nature. M. Gleeson. (1982). Br. J. Nutr. Joo Young Huh. (2012). Metabolism. JAMES O. HILL. (1983). Physiology & Behavior. CONTACT Nooshin@med.med.osaka-cu.ac.jp

## Mini-Orals

### MO-BN05 Motor learning

#### ANALYSIS OF THE NO RETURN OF POINT HYPOTHESIS: THE EFFECT OF AUDIO AND VISUAL STIMULI IN THE FAST MOVEMENTS INHIBITION

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**Introduction** Various studies have been conducted in the conformation of the no return of point hypothesis. Almost in many studies, motor program's concept and inability to stop after the start point can be seen. Gao and Zilaznig (1991) evaluated the Henry and Harrison's hypothesis in detail. They showed that maybe the task type, the scaling and the data analysis methods for motor pattern are affecting the results. Therefore, due to this study we controled the task type and stimulus presented. This study intends to answer this question that does the no return of point change by changing the nature of variables (task type, stimulus type). **Methodology** Participants were 50 graduate student volunteers. In three experiment we examined difference between stimulus in reaction time (experiment 1) and effect of stimulus type on stop-signal paradigm (experiment 2) also, we examined effect of task type with changing the stop-go time and both analogue and digital stopwatch (experiment 3). The experiments were designed similar to Slater and Hammel's pattern and consist of a software and a hardware of a stopwatch with visual, audio and combined stimuli. **Results** Data was analyzed by ANOVA and analysis of variance with repeated measures. The results of experiments showed that the difference between groups in audio and visual stimuli are significant ( $F=8.323$ ,  $P=0.00$ , experiment 1). Participants have learned the presented pattern in retention stage. In the transfer stage, they were compared about each of the time provided. In some of the times, differences between groups were significant (experiment 2). The third experiment results showed A significant advantage in favor of the visual analogue was found ( $p = 0.041$ ). **Discussion** In first experiment participants in audio group were better than the others. (Shelton and Kumar 2010). In the second experiment, The groups behave the same and the parameters affected by the times are the same. This shows that a motor program is active before and after the stop time and is run on the time spectrum the time of no return point is longer than Slater-Hammel's report (210 msec). Moreover, based on the third experiment result, participant's response to the stop time is highly dependent on task type. Probably, the Slater-Hammel's results have influenced by task type and also the used variable of statistical analysis. Finally, we suggest that intentional behavior may be controlled by top-down hierarchical mechanism, while the participant does not expect the stop time, it follows the direct perception process. **Reference:** 1. Slater-Hammel, A. T. (1960). Reliability, accuracy, and refractoriness of a transit reaction. *Research Quarterly*. American Association for Health, Physical Education and Recreation, 31(2), 217-228. 2. Shelton, Jose, and Gideon Praveen Kumar. 'Comparison between auditory and visual simple reaction times.' *Neuroscience & Medicine* 1.1 (2010): 30-2. Contact: askakhki@um.ac.ir

#### CHANGES IN COORDINATION DURING LEARNING A GYMNASTICS SKILL

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**Introduction** During skill learning technique of a performer must better satisfy the mechanical demands of the task for performance to improve. Motor control, and synonymously motor learning, research is interested in understanding, explaining in terms of control, and predicting technique changes during learning. However, there are a number of missing links between our biomechanical understanding of skills and motor learning theory in the natural physical setting of sports skill learning. This work explores changes in characteristics of technique that are underpinned by the dynamical systems theory of motor control, how they contribute to our understanding of skill learning and the subsequent practical implications of this research. **Methods** Two groups of novices; one successful ( $n = 4$ ), and one unsuccessful ( $n = 4$ ), performed the gymnastics longswing on high bar during five practice sessions. Two expert gymnasts performed five sets of longswing a during one testing session. Kinematic data (Coda motion) were collected during swing attempts. Continuous Relative Phase (CRP) of the hip and shoulder motions was examined for the longswing a performed by the two groups of novices and the two expert gymnasts. Principal Component Analysis (PCA) was used to identify changes in the CRP profiles of novices over practice, and to investigate the characteristics that distinguished successful from unsuccessful novices. **Discussion** PCA did not distinguish successful from unsuccessful novices CRP profiles. When examining hip and shoulder CRP profiles of successful novices in comparison with those of expert gymnasts PCA showed that successful novices technique became more out-of-phase over the practice period, and less similar to the closely in-phase technique of the elite gymnasts. These findings support the proposition that at the level of inter joint coordination a technique emerges over practice that facilitates successful performance for novices but is less like that of elite gymnasts performing the skill. The findings questions the appropriateness of inferring development towards a 'gold champion' technique when defined by movement coordination.

## DO JUMP ABILITY, SPRINTING AND BALANCE INFLUENCE AGILITY OF JUNIOR HIGH AND HIGH SCHOOL FEMALE SOCCER PLAYERS?

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**Introduction** Agility that can change direction quickly is important for soccer players. A purpose of this study was to examine factors to influence agility of female soccer players. **Methods** The participants were 29 junior high and high school female soccer players. Two kinds of agility tests that Japan Football Association recommends were measured, which were Agility test 1 to assess agility corresponded to defense and Agility test 2 to assess agility corresponded to offence. Isometric maximum muscle strength of hip abduction and extension, and isokinetic peak torque of knee flexion and extension (60 degrees /sec) on a pivot leg were measured. Other tests included linear sprints (40m), hopping test (the distance of three steps jumping with one leg) and Modified Star Excursion Balance Test (MSEBT). We examined the correlation of the times of two agility tests and the results of other tests using Pearson's product-moment correlation coefficient. **Results** The times of Agility test 1 were significantly related to the knee extension peak torque ( $r = -.45, p < .05$ ), the knee flexion peak torque ( $r = -.61, p < .01$ ), the right hopping test ( $r = -.57, p < .01$ ), the left hopping test ( $r = -.61, p < .01$ ), linear sprint times ( $r = .51, p < .01$ ), the hip abduction muscle strength ( $r = -.37, p < .05$ ), the hip extension muscle strength ( $r = .37, p < .05$ ). The times of Agility test 2 were significantly related to the knee extension peak torque ( $r = -.41, p < .05$ ), the knee flexion peak torque ( $r = -.50, p < .01$ ), Right hopping distance ( $r = -.39, p < .05$ ), Left hopping distance ( $r = -.47, p < .01$ ), linear sprint times ( $r = .57, p < .01$ ), the hip abduction muscle strength ( $r = -.44, p < .05$ ). The results of both agility tests did not show any correlations with the MSEBT. **Discussion** The agility of the junior high and high school female soccer players did not show any correlations with the ability for dynamic balance (MSEBT) shew comparatively higher Pearson's correlations between knee flexion peak torque, hopping distance and linear sprint times. Seulic et al. reported agility was significantly related to the balance for males but not for females and the female agility had weak correlation with power. The Vescovi et al. report linear sprint times and the vertebral jump correlated with agility of the female athletes. Our research suggested ability was related to the power, such as knee muscle strength, jumping performance and linear sprints, should be considered to improve agility of junior high and high school female soccer players. **References** Sekulic D, Spasic M, Mirkov D, Cavar M, Sattler T. (2013) *J Strength Cond Res.* 27, 802-11 Vescovi JD, McGuigan MR. (2008) *J Sports Sci.* 26, 97-107.

## LEARNING MOVEMENT PHASES DURING EARLY STAGES OF MOTOR LEARNING

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**Introduction** Traditionally, in motor learning research the process of learning a new motor skill is evaluated by measuring repeatedly the performing of the to-be-learned motor skill as whole (e.g., Hodges, Hayes, Horn, & Williams, 2005). However, it is not clear if the individuals learn various phases of a new motor skill, i.e., preparatory, main, or end phases similarly or differentially. Principally, a lack of a detailed analysis of movement phases during the process of motor skill learning can be determined in the motor learning literature. Therefore, the present study attempts to bridge this gap and provide some new data on learning movement phases by the example of a complex throwing skill. **Methods** Participants were eight male and female young adults. Due to its clear movement phase structure, Baseball-pitch was chosen as motor task. To introduce motor task to participants, they were shown instruction material consisted of static pictures of pitch phases and additional notes related to each phase. Participants were then asked to perform five trials in a pretest followed by three blocks of ten trials in the acquisition phase. Two retention test, each with five trials, were conducted ten minutes and seven days after last block. All trials of pretest and retention tests and first three trials of each acquisition block were filmed by four synchronized digital cameras for later kinematic analysis. Intra- and inter-limb coordination of upper- and lower body segments were measured as dependent variables. **Results** Data of movement phases were compared to each other (PHASE) and from pretest to acquisition blocks and retention tests (TIME). Moreover, data of intra- and inter-limb coordination were also compared to each other (LIMB) and from pretest to acquisition phase and retention tests (TIME). Results of comparing the movement phases showed that there was a significant main effect for PHASE ( $F = 4.62, p < .05$ ), TIME ( $F = 3.70, p < .01$ ), INTERACTION ( $F = 4.48, p < .001$ ). In this regard, there were significant differences between the stride phase and the other phases. Results of comparing the intra- and inter-limb coordination showed that there was no significant main effect for LIMB (intra- and inter-limb coordination) ( $F = 2.17, p > .1$ ), TIME ( $F = 3.70, p > .1$ ), or INTERACTION ( $F = 1.02, p > .1$ ). **Discussion** Results indicate that the participants had more problem with coordinating the stride phase than the other pitch phases (as shown by significant main effect for PHASE) while performed the pitch and became gradually better with practice (as shown by significant main effect for TIME). One explanation for these results might be that the stride phase is the only segment in which the participants had to move upper and lower body parts (right arm and left leg) simultaneously. Due to this feature, they needed to unfreeze more degrees of freedom, which led to inferior coordination performance in this phase (Bernstein, 1967).

## THE ROLE OF VIDEO MANIPULATION IN SKILL ACQUISITION

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**Introduction** The use of temporal and spatial occlusion are well established methods to obtain visual information and subsequent mechanisms underlying sport skills when comparing athlete levels and progression of learning. Although temporal occlusion may meet ecological validity, the use of spatial occlusion in research (Panchuk & Vickers, 2009; Williams & David, 1998) where sections of the body are no longer visible may cause concerns for poor ecological validity. Therefore, the aim of this abstract is to discuss the use of video manipulation as a tool for analysing anticipation. **Methods** This abstract involves data taken from a previous study by the authors where video of a striker kicking a penalty kick was digitally manipulated by changing the standing leg depending on direction. Three groups depending on skill where used, goalkeepers ( $n = 17$ ), field players ( $n = 20$ ) and control group ( $n = 20$ ). An eye tracker was worn whilst watching 40 videos of a striker kicking at the goal in randomised placement order (left or right and high or low). All 40 videos were temporally occluded at foot-to-ball contact and the non-kicking leg of 20 videos were spatially manipulated. **Results** As shown in Tamara et al., (2015), the results of using a video spatial manipulation method for the football penalty kick showed similar effects as previous research (Savelsbergh et al. 2002) for predominately final fixations occurring at the stance foot (37.6%) and the ball (33.7%). There was no significant difference for goalkeepers' prediction the direction of the ball in either the manipulated or controlled condition. **Discussion** This is the first time that video spatial manipulation has been used and it appears that the results mimic previous research with spatial occlusion. However, it has been shown that once the stance leg is occluded performance decreases, this was not the case when the video was manipu-



lated. Future research should look at comparing the methods to determine which would be more useful from an ecological point of view. References Panchuk, D., & Vickers, J. N. (2009). Using spatial occlusion to explore the control strategies used in rapid interceptive actions: Predictive or prospective control? *J Sports Sci*, 27(12), 1249-1260. Savelsbergh, G. J., Williams, A. M., Van der Kamp, J., & Ward, P. (2002). Visual search, anticipation and expertise in soccer goalkeepers. *J Sports Sci*, 20(3), 279-287. Woolley, T.L., Crowther, R.G., Doma, K., Connor, J.D. (In press). The use of spatial manipulation to examine goalkeeper's anticipation. *J Sports Sci*. Williams, A. M., & Davids, K. (1998). Visual Search Strategy, Selective Attention and Expertise in Soccer. *Res Q Exerc Sport*, 69(2), 111-128. Contact Robert.Crowther@usq.edu.au

### **HOW TO MAXIMIZE PERFORMANCE? INFLUENCE OF COMBINING AUGMENTED FEEDBACK WITH AN EXTERNAL FOCUS OF ATTENTION AND WITH REWARD**

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**Introduction** It was previously demonstrated that jump height could be improved in the short and long-term when providing augmented feedback (aFB) (Keller et al. 2014a). Furthermore, aFB was superior to an internal (IF) or external focus (EF) of attention for maximizing jump performance (Keller et al. 2014b). For the present study, we introduced a monetary reward condition (RE) and combined aFB with an EF and with RE. We hypothesised that if the underlying mechanisms of aFB, EF and RE are not redundant, we should see most beneficial effects when combining these conditions. **Method** 18 adults (26.6±8.9 years, 1.74±0.09 m, 71.4±12.7 kg; 8 female and 10 male) were performing counter movement jumps (CMJs). Participants were told to jump as high as possible in each single trial and to respect the additional instructions. Each participant executed 16 series of six maximal CMJs distributed to the following six conditions: Neutral (NE), aFB, RE, aFB+EF, aFB+RE and aFB+EF+RE. Each condition was repeated twice and the order was randomized for each participant. **Results** Participants showed the highest jump heights with aFB+EF (39.30±6.65 cm) and, as expected, the worst in the NE condition (38.15±7.05 cm). A one-way ANOVA with repeated measures revealed significant differences between conditions ( $F_{5,45} = 9.092$ ;  $p < 0.01$ ;  $n_2p = 0.348$ ). Post-hoc analysis with Bonferroni corrected t-tests indicated clear differences between NE and aFB+EF ( $p < 0.01$ ), NE and aFB+EF+RE ( $p < 0.01$ ), NE and aFB+RE ( $p = 0.044$ ), aFB and aFB+EF ( $p = 0.014$ ) and RE and aFB+EF ( $p = 0.014$ ). No significant differences between conditions concerning force production, muscular activity or movement kinematics were observed. **Discussion** Three conditions (aFB+EF, aFB+EF+RE and aFB+RE) showed significantly superior performance compared to the NE condition. The aFB+EF condition was, however, the only condition that was significantly superior compared to aFB and RE alone and may therefore be considered as the most efficient approach to maximize jump performance.

### **BEHAVIORAL DIFFERENCES IN PRESCHOOL CHILDREN WITH VARYING LEVELS OF MOVEMENT ABILITY DURING FREE PLAY**

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**Introduction** Early childhood is a critical period for the development of fundamental movement skills (FMS). FMS acquisition is developmentally sequenced and contingent upon the acquisition process occurring through a range of active play experiences. FMS competency may be associated with physical activity level. However, sufficiently rich repertoires of movement often do not occur in daily physical activity. In this study, we clarify differences between movement variations of children with greater FMS and children with lower FMS in early childhood in order to determine what support FMS acquisition may require. **Methods** Participants were typically developing preschool children aged 4–6 years. We made video recordings of participants during free play in preschool for roughly 30 minutes consecutively. From these video recordings, we observed children's movements in terms of moment-to-moment changes in all behaviors, and categorized roughly 30 movements, for example, "walk," "run," "jump," "throw," and "lie down." We analyzed the number of times each movement occurred, each movement's frequency, and the time duration of each movement occurrence. The behavioral patterns of children with different FMS levels were examined. **Results** Generally, larger repertoires of movement were observed in children with greater FMS than in children with less. However, age and gender differences were also observed. Overall, locomotive movements such as 'walk' and 'run' were most commonly observed during free play activities. However, certain movements, such as some object control skills, were observed at very low rates in all video recordings. **Discussion** In this observational study, children with greater FMS, particularly boys, performed a larger repertoire of movement than children with lower FMS. Previous research has indicated positive associations between FMS competency and physical activity level (Fischer et al, 2005, Williams et al, 2008). In contrast, it has been reported that object control skill competence was not associated with moderate-to-vigorous physical activity. Preschool children's FMS are still somewhat rudimentary. Hence, during the preschool period, various physical activities may drive the development of motor skill competence (Stodden et al. 2008). From our findings, we suggest the need to provide structured opportunities that facilitate children's acquisition of FMS, which may include providing unfamiliar movement activities, games, equipment and spaces. **References** Fisher et al. (2005), *Med. Sci. Sports Exerc.*, 37,684-8 Williams et al. (2008), *Obesity*, 16,1421-1426. Stodden et al. (2008), *Quest*, 60,290-306. Contact: sasaki@z6.keio.jp

### **THE MOTOR PROFICIENCY OF ADOLESCENTS USING MABC-2 AGE BAND 3**

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**THE MOTOR PROFICIENCY OF ADOLESCENTS USING MABC-2 AGE BAND 3** **Introduction** Motor assessment plays a vital role in the comprehension of motor development of children and adolescents. Many studies have used the Movement Assessment Battery for Children-2 (MABC-2; Henderson, Sugden & Barnett, 2007) of different age bands to evaluate motor proficiency of children and adolescents. The only relevant study conducted in Singapore was to identify the young children with coordination problems using the first version of MABC. However, information of the motor proficiency of adolescents in Singapore, including the use of MABC-2 age band 3 has not been well documented. Therefore, the objective of this study was to evaluate the motor proficiency of Singaporean adolescents using MABC-2. **Methods** Thirty adolescents ( $n = 30$ ; 15 males, 15 females; age range: 13 – 16 years), without pre-existing medical or health conditions, from different regular schools in Singapore volunteered for this study. Ethics procedures via internal institutional review committee were conducted and approved. Parental consent was obtained. The eight motor tasks of MABC-2 (Henderson, Sugden & Barnett, 2007) were grouped according to three task components of 1) manual dexterity, 2) aiming and catching and 3) static and dynamic balance to evaluate the motor proficiency of the participants. **Results** The results showed no significant gender difference between male and female

adolescents ( $p > .05$ ). However, one-sample t-test revealed that the participating adolescents performed significantly poorer balance component as well as total standard scores as compared to the MABC-2 normative data ( $p \leq .05$ ) which was established based on UK population. Discussion While the maturation of balance control has been documented to stabilise by the age of 10, the poorer balance abilities of Singaporean adolescents suggests that they were not as proficient as they should be. While this could be explained by varied PE lessons in different cultural settings, it could be mitigated because the norms were based on a UK population. Given that there is no significant difference for other task components between participating adolescents and the MABC-2 normative sample, it is recommended that more balance-focused physical activities could be incorporated during PE lessons in Singapore. Reference Henderson S.E., Sugden, D.A., & Barnett, A. L. (2007). *The Movement assessment battery for children* (2nd ed.). London, UK: Harcourt Assessment.

## Mini-Orals

### MO-PM10 Adapted physical activity: Nutrition

#### THE EFFECTS OF LOW AND HIGH CARBOHYDRATE DIET ON WEIGHT AND FAT LOSS DURING ENERGY RESTRICTION FOR ATHLETES IN SHORT-TERM

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The effects of low and high carbohydrate diet on weight and fat loss during energy restriction for athletes in short-term Makiko Toguchi<sup>1</sup>, Hiroyuki Sagayama<sup>1</sup>, Takaya Hirota<sup>2</sup>, Kouhei Shimada<sup>2</sup>, Ikumi Yamazaki<sup>2</sup>, Yasuki Higaki<sup>2,3</sup>, Akira Kiyonaga<sup>2,3</sup>, Hiroaki Tanaka<sup>2,3</sup>  
<sup>1</sup>Graduate School of Sports and Health Science, Fukuoka University, Fukuoka, Japan. <sup>2</sup>Faculty of Sports and Health Science, Fukuoka University, Fukuoka, Japan. <sup>3</sup>Fukuoka University Institute for Physical Activity, Fukuoka, Japan. Introduction Low carbohydrate (LC) diet is one of the popular diets to decrease weight loss. For some athletes, it is desired to decrease their body weight (BW) to optimize performance. To reduce the BW, an energy deficit is needed and the amount of weight loss depends on energy deficit. Therefore, BW could be reduced when energy expenditure (EE) increases, energy intake (EI) decreases, or combination of the two. If it is under the same energy deficit conditions, the same amount of BW and fat reduction could be achieved whether diet contents are low or high carbohydrate (HC). The objective in the study was to investigate the effects of LC and HC diet on weight and fat loss during energy restriction for athletes in a 1-week. Methods The subjects were eleven (7 men and 4 women, age: 20.1±1.1 years; height: 171.9±6.8 cm; BW: 65.0±7.2 kg). They participated in weight loss intervention program for a 1-week and were assigned randomly to 2 groups (LC (n=6) and HC diet group (n=5)). Daily EI were 1100~1400kcal, which was based on individual body mass index. LC diet was set 40% fat, and 30% carbohydrate. HC diet was set 20% fat, and 50% carbohydrate. Both diets were set 30% protein (1.4~1.5g/kg/day). In addition to their usual training, they conducted interval-jogging program for 1 hour (repeated cycles of running for 1 minute and walking for 30 seconds) twice every day. Body composition and Total EE were measured by the doubly labeled water method before and after the intervention. Results BW and fat mass (FM) were significantly decreased in both groups during intervention, respectively (BW and FM, LC:1.9±1.0 and 1.7±1.3 kg, HC:1.8±1.0 and 1.7±0.6 kg). But total body water and fat-free mass was not changed in the both group. Total EE was 3416±416kcal/day for the LC group, 3424±444kcal/day for the HC group. EI was 1285±95kcal/day for the LC group, 1335±150kcal/day for the HC group. Physical activity level was 2.6±0.3 for the LC group, and 2.4±0.2 for the HC group. Discussion BW and FM were decreased in LC and HC diet groups but not significant difference in groups. But fat-free mass did not change in both groups. Therefore, LC diet and HC diet would be same effect of weight loss under the same energy deficit. It could be possible to choice of meal for athletes who want to lose weight. References Stuart M. Phillips. A Brief Review of Higher Dietary Protein Diets in Weight Loss: A Focus on Athletes Correspondence: toguchi\_makiko@yahoo.co.jp

#### LACTOTRIPEPTIDES SUPPLEMENTATION AFFECTS BRACHIAL ARTERIAL DIAMETER AND MAXIMAL ISOMETRIC FORCE FOLLOWING HIGH-INTENSITY ECCENTRIC EXERCISE.

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Introduction Maximal isometric force (MIF) decreases following high-intensity eccentric exercise (ECC). Brachial arterial diameter increases following ECC. Lactotripeptides (LTP), two active tripeptides, valine-proline-proline and isoleucine-proline-proline, have vasodilative effect. The purpose of this study was to investigate that whether LTP supplementation improves MIF and brachial arterial diameter following ECC. We hypothesized that LTP supplementation would increase brachial arterial diameter and suppress decreased MIF following ECC. Methods 22 young healthy men (age, 23.8 ± 1.7 years) were randomly assigned to two groups (placebo + ECC: placebo group, LTP + ECC: LTP group) and given a 4.8 mg/day placebo or LTP, thirty minutes before ECC, one hour following ECC, and three hours following ECC. In the next day, placebo or LTP supplementation ingested in the morning, evening, and night. All subjects performed 50 repetition unilateral maximal-effect ECC of the elbow flexors on the Biodex isokinetic dynamometer, with each contraction lasting 1 sec with one repetition performed 12 sec as described previously (Choi et al. 2014). Blood pressure (SBP, MBP, DBP, and PP), heart rate (HR), MIF in the biceps brachii, and brachial arterial diameter in the exercised arm assessed before and 2 days after ECC. Results There were no differences in blood pressures and HR between two groups during experiment. MIF following ECC significantly decreased in placebo group ( $p < 0.01$ ) and LTP group ( $p < 0.05$ ). The decreased MIF tended to be depressed by LTP ingestion ( $p = 0.15$ ). Brachial arterial diameter following ECC did not change in placebo group. In contrast, brachial arterial diameter following ECC significantly increased in LTP group ( $p < 0.01$ ). The change in MIF significantly related to change in brachial arterial diameter after adjusting for weight ( $p < 0.05$ ). Discussion This study showed that LTP supplementation improved changes in brachial arterial diameter following ECC. Previous study showed that LTP supplementation significantly increased nitric oxide production in a dose-related fashion (Hirota et al. 2011). Nitric oxide has vasodilative effect. Therefore, LTP supplementation may have beneficial effect on MIF via its vasodilative effect following ECC. Conclusion The present results suggest that LTP supplementation may have beneficial effect on MIF and brachial arterial diameter following ECC. References Choi et al., 2014. *J Strength Cond Res.* (in press). Hirota et al., 2011. *Heart Vessels.* 26 (5): 549-56. Contact tagawakaname@gmail.com

**DOES CAFFEINE SUPPLEMENTATION LEAD TO DEHYDRATION IN TENNIS PERFORMANCE IN CAFFEINE-NAÏVE PLAYERS?**

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Introduction: It has been suggested that ingestion of caffeine at least 1 hour prior to a tennis match may improve performance and the ergogenic effects remain present until 6 hours after ingestion, without any significant effects on hydration status. One limitation to these studies is that they did not ascertain the effects of caffeine when consumed on a regular basis. Therefore the purpose of this investigation was to determine the effect of pre-match consumption of caffeine by caffeine-naïve players on hydration status during a tennis match, through a within-subjects placebo-controlled design. Methods: Six highly skilled tennis players between the ages of 18-25 participated in this study. Participants had a daily caffeine consumption below 50mg. Participants performed three tennis matches. In one match the players received 5mg.Kg<sup>-1</sup> of caffeine 1 hour prior to it ('Caffeine'), in another one they received an inert placebo ('Placebo') and in the other they didn't consume anything beyond water ('Baseline'). The degree of dehydration was assessed through the fluid loss during the match: nude body weight (BW) was measured using a digital scale (GSE Scale Systems, Model 550) before and after the match. Repeated measures analysis of variance (ANOVA) was used to test differences in mean scores under the three conditions and Wilcoxon signed-rank test was used to compare the repeated measurements of BW before and after match. Results: No differences between conditions were observed for fluid loss during the match. There was no significant difference between the BW before and after match in any condition and therefore the frequency and amount of water ingestion are sufficient to prevent dehydration under the climatic conditions experienced during the study. Discussion: A caffeine dose of 5mg.Kg<sup>-1</sup> does not lead to a significant degree of dehydration among caffeine-naïve tennis players. Thus, the diuretic effects of caffeine are not sufficiently significant to depreciate its ergogenic effects on performance. In this study there were significant differences between the sweat rates of the participants, suggesting that tennis players should follow an individualized hydration plan in order to optimize their hydration levels during training sessions or competitions. References: Strecker, E. (2007) The effect of caffeine ingestion on Tennis Skill Performance and Hydration Status. Auburn Theses and Dissertations Bell, D.G., & McLellam, T.M. (2002) Exercise endurance 1, 3, and 6 hours after caffeine ingestion in caffeine users and nonusers. *Journal of Applied Physiology*, 93: p. 1227-1234 Kovacs, E.M.R., Stegen, J.H.C.H., & Brouns, F., (1998) Effect of caffeinated drinks on substrate metabolism, caffeine excretion, and performance. *Journal of Applied Physiology*, 85(2): p. 709-715 Kovacs, M.S., Hydration and temperature in tennis—a practical review. *Journal of Sports Science and Medicine*, 2006. 5: p. 1-9 Contact: rnomesquita@hotmail.com

**A SEVEN-DAY HIGH-FAT, HIGH-ENERGY DIET IMPAIRS GLYCAEMIC CONTROL BUT DOES NOT DISRUPT THE POST-PRANDIAL ACYLATED GHRELIN RESPONSE TO A MIXED MEAL**

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Introduction: Insulin resistance is a major characteristic of obesity and type II diabetes. Although the obesity epidemic is undoubtedly caused by a chronic positive energy balance, the early metabolic responses to overeating are poorly described in humans. Thus, the aim of this study was to determine changes in glycaemic control after 7 days high-fat overfeeding. Method: Nine healthy individuals performed a MTT before and after consuming a high-fat (65%) high-energy (+50%) diet for seven days. Daily energy requirements were estimated using equations for resting energy expenditure corrected for reported physical activity. This value was then used as a baseline to calculate the amount of food required for the overfeeding period. The MTT provided 3227 kJ; 30 g fat, 112 g carbohydrate and 19 g protein. Plasma glucose and serum insulin concentrations were determined at baseline and at 30 min intervals throughout MTT for assessment of whole-body glycaemic control. Plasma triglyceride and acylated ghrelin concentrations were also determined at 30 min intervals; with acylated ghrelin being used as a biological marker for potential changes in appetite regulation. Results: Estimated daily energy requirements were 10717 ± 481 kJ. During the 7-day overfeeding period, subjects were provided with 16075 ± 722 kJ per day; 10449 ± 465 kJ (277 ± 12 g) from fat. Body mass increased by 0.79 ± 0.14 kg after 7-days overfeeding (p < 0.0005). Fasting plasma glucose increased from 5.5 ± 0.12 mmol/L before overfeeding to 5.8 ± 0.08 mmol/L after (p = 0.016), whereas fasting plasma insulin was unaffected (71 ± 8 and 82 ± 9 pmol/L before and after overfeeding, respectively, p > 0.05). Glucose AUC increased by 11.6% (1020 ± 74 vs. 1138 ± 56 mmol/L/180 min, p = 0.009) and insulin AUC increased by 25.9% (53267 ± 6375 vs. 67046 ± 6849 pmol/L/180 min, p = 0.006). Plasma acylated ghrelin decreased following ingestion of the MTT, with the lowest concentrations being observed at 30 min and remaining suppressed for 180 min; however, this response was not affected by overfeeding. Conclusion: A 7-day high-fat, high-energy diet rapidly disrupts whole-body glycaemic control. Therefore, this experimental model may be useful when studying the early responses and underlying mechanisms behind the development of insulin resistance and type II diabetes in humans without the confounding factors associated with obesity. The postprandial acylated ghrelin response to MTT was unaffected by 7 days of overfeeding, suggesting that either a longer diet challenge may be needed to disrupt appetite regulation or that acylated ghrelin levels do not respond to changes in energy balance, but this requires further investigation.

**EFFECT OF LACTOFERRIN ON LIPOLYTIC ACTIVITY UPON CATECHOLAMINE STIMULATION IN 3T3-L1 ADIPOCYTES**

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Introduction Lactoferrin (LF) is a multifunctional glycoprotein in mammalian milk. In a previous report, we showed that an 8-week administration of LF resulted in decreased visceral fat accumulation in Japanese men and women with abdominal obesity. Furthermore, we also found that the LF treatment to mature adipocytes elevated basal lipolytic activity concomitant with increased intracellular cAMP. However, it is not clear whether LF treatment could increase lipolytic activity upon catecholamine stimulation in adipocytes. The aim of this study was to examine the effect of LF treatment on lipolytic activity upon catecholamine stimulation in 3T3-L1 adipocytes. Methods 3T3-L1 cells were grown in 12-well dishes. Differentiated cells were treated with DMEM containing with (LF) or without (CON) 1mg/mL LF for 3 days. After the treatment, lipolytic activity was analyzed by incubating cells with DMEM containing 2% fatty acid-free BSA/20 mM HEPES-NaOH (pH 7.4) with 0.5 mM IBMX and 10 µM isoproterenol at 37°C. After incubation for 3 hrs, aliquots of the medium were collected and assayed for glycerol and fatty acid (FA) contents using TG E-test kit and NEFA C-test kit, respectively. Triacylglycerol (TAG) was also measured using a TG E-test kit. The expressions of lipid-associated proteins were analyzed by western blotting. Results The TAG content in mature adipocytes treated with LF for 3 days was significantly decreased upon catecholamine stimulation as compared with CON (p < 0.01), although lipolytic activity as estimated by the glycerol release was not increased by LF treatment. On the other hand, LF significantly increased the FA release as compared with CON (p < 0.01). The expression of diacylglycerol acyltransferase1 (DGAT1), one of the lipid

synthesis-associated proteins, was significantly decreased in mature adipocytes treated with LF for 3 days as compared with CON ( $p < 0.05$ ). Discussion These results suggest that LF inhibits resynthesis of FA into TAG during lipolysis via the reduction of DGAT1, thereby decreasing TAG content upon catecholamine stimulation in 3T3-L1 adipocytes. References Ono, T., Murakoshi, M., Suzuki, N., Iida, N., Ohdera, M., Iigo, M., Yoshida, T., Sugiyama, K., and Nishino, H. (2010). Potent anti-obesity effect of enteric-coated lactoferrin: decrease in visceral fat accumulation in Japanese men and women with abdominal obesity after 8-week administration of enteric-coated lactoferrin tablets. *British Journal of Nutrition*. 104 (11), 1688-1695. Ono, T., Fujisaki, C., Ishihara, Y., Ikoma, K., Morishita, S., Yoshida, T., and Nishino, H. (2013). Potent Lipolytic Activity of Lactoferrin in Mature Adipocytes. *Bioscience, Biotechnology, and Biochemistry*. 77 (3), 566-571. Contact Takeshi Hashimoto [thashimo@fc.ritsumei.ac.jp]

### LONG-TERM VITAMIN D3 SUPPLEMENTATION PREVENTS VITAMIN D DEFICIENCY

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Background: Vitamin D deficiency is highly prevalent among athletes, especially during winter months [1]. Recent studies show that a sufficient vitamin D status can increase sports performance [2, 3]. It remains unclear what dosage of vitamin D3 is needed to achieve a sufficient vitamin D status in elite athletes. Purpose: To assess the prevalence of vitamin D deficiency in Dutch athletes and to define the required dosage of vitamin D3 to prevent vitamin D deficiency over the course of a year. Method: A total of 128 highly trained athletes were recruited and blood samples were collected to assess 25(OH)D status. Of these 128 athletes, 54 male and 48 female athletes (18-32 y) were included in a randomized, double blind, dose-response study. Athletes with a deficient (<50 nmol/L) or insufficient (50-75 nmol/L) 25(OH)D status were randomly assigned to take 400, 1100 or 2200 IU vitamin D3 per day for one year. Athletes who had a 25(OH)D status above 75 nmol/L received no supplements and were monitored only. Serum 25(OH)D was assessed every 3 months as well as vitamin D intake and sunlight exposure. For subjects who reached a 25(OH)D level of >125 nmol/L dose was adjusted to a maintenance dose of 400 IU/d. Results: Nearly 70% of all athletes showed an insufficient (50-75 nmol/L) or deficient (<50 nmol/L) 25(OH)D status at baseline. After 12 months, serum 25(OH)D increased more in the 2200 IU/d group (50±27 nmol/L) compared to the sufficient group (4±17 nmol/L;  $P < 0.01$ ) and the 1100 IU/d group (25±23 nmol/L;  $P < 0.05$ ), as analyzed using linear mixed models. Vitamin D supplementation with 2200 IU/d resulted in a sufficient vitamin D status in 85% of the athletes after 3 months and in 80% of the athletes after 12 months. Conclusion: Vitamin D deficiency is highly prevalent in athletes. Supplementing 2200 IU vitamin D3 per day prevents vitamin D deficiency throughout the course of the year. References: 1. Farrokhyar, F. et al. (2014). Prevalence of Vitamin D Inadequacy in Athletes: A Systematic-Review and Meta-Analysis. *Sports Med*. 2. Close, G.L. et al. (2013). The effects of vitamin D3 supplementation on serum total 25(OH)D concentration and physical performance: a randomised dose-response study. *Br J Sports Med*. 3. Maroon, J.C. et al. (2015). Vitamin D Profile in National Football League Players. *Am J Sports Med*. Contact: Evelien.Backx@wur.nl

### INFLUENCE OF A 5-DAY FASTING PERIOD ON ISOMETRIC MAXIMAL STRENGTH AND JUMPING HEIGHT OF HEALTHY YOUNG ADULTS

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Introduction Fasting is the abstinence from eating or drinking over a defined period of time for one or several days or a longer period. It is a traditional method to support the treatment of cardiometabolic diseases, to improve general physical and psychological wellbeing (Li et al., 2013) and has a beneficial effect on inflammation and oxidative stress (Dannecker et al., 2013). More and more physically active people use fasting for improvement of wellbeing or other reasons. It is not known in detail how short-lasting nutrient restriction affects performance. The aim of this study was to analyze the influences of a 5-day fasting period on isometric maximal grip strength (IMGS) and strength of knee extension (IMSK), and jumping height (JH) in the counter-movement jump (CMJ) and squat jump (SJ). Methods 20 healthy young physically active adults (n=10 male, n=10 female, age: 24.6±/-6.7 years, height: 1.76±/-0.09 m, weight: 73.9±/-11.9 kg) volunteered to participate in a 5-day fasting period according to the Buchinger method, which allows fruit and vegetable juices, honey and vegetable broth with a total caloric intake of maximally 500 kcal per day. IMGS, IMSK and JH were analyzed 2 days before, on the 5th day within and 2 days after the fasting period. IMGS was tested by the JAMAR hydraulic hand dynamometer with a 3-sec maximal voluntary contraction followed by a 15 second break. IMSK was determined in a fixed sitting position by means of a force transducer with 6-sec maximal voluntary contraction followed by a 30 sec break. 3 trials were assessed. IMGS and IMSK were conducted separately for the right and left hand and leg. For statistics we used the mean values of the 3 trials. JH was assessed via contact mats with 2 tests for CMJ and SJ, respectively, and the mean value being used for statistics. Statistics included ANOVA and paired t-Test. The level of significance was set as  $p < 0.05$ . Results Grip strength of both hands increased after the fasting period (right hand: 6.5%, left hand: 6.0% ( $2p < 0.05$ )). Isometric maximal strength of knee extension and jumping height in CMJ and SJ remained unaffected. Discussion A 5-day fasting period did not negatively influence isometric maximal strength of knee extension and jumping height in CMJ and SJ. Slight increases in grip strength are probably due to learning effects but not due to metabolic alterations during and after the fasting period. A short-lasting fasting period according to the Buchinger method does not negatively influence muscle strength and might be used by healthy physically active people. References Dannecker E, Liu Y, Scott R et al. (2013). *Exp Gerontol*, 48(10), 1101-1106 Li C, Ostermann T, Hardt M et al. (2013). *Forsch Komplemen-tmed*, 20, 413-420 Contact Carla.Hentz@rub.de

### CURCUMIN SUPPLEMENTATION LIKELY ATTENUATES DELAYED ONSET MUSCLE SORENESS

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Oral curcumin decreases inflammatory cytokines and increases muscle regeneration in mice. Purpose. To determine effects of curcumin on muscle damage, inflammation, and delayed onset muscle soreness (DOMS) in humans. Method. Seventeen men completed a double-blind randomized controlled crossover trial to estimate the effects of oral curcumin supplementation (2.5 g twice daily) versus placebo on single-leg jump performance and DOMS following unaccustomed heavy eccentric exercise. Curcumin or placebo were taken 2-d before to 3-d after eccentric single-leg press exercise, separated by 14-d washout. Measurements were made at baseline, and 0, 24, and 48-h post-exercise comprising: (a) limb pain (1-10 cm visual analogue scale; VAS), (b) muscle swelling, (c) single leg jump height, and (d) serum markers of muscle damage and inflammation. Standardized magnitude-based inference was used to define outcomes. Re-

sults. At 24-h and 48-h post-exercise, curcumin caused moderate-large reductions in pain during single-leg squat (VAS scale -1.4 to -1.7; 90%CL:  $\pm 1.0$ ), gluteal stretch (-1.0 to -1.9;  $\pm 0.9$ ), squat jump (-1.5 to -1.1;  $\pm 1.2$ ), and small reductions in creatine kinase activity (-22% to 29%;  $\pm 21\%$  to 22%). Associated with the pain reduction was a small increase in single-leg jump performance (15%; 90%CL  $\pm 12\%$ ). Curcumin increased interleukin-6 concentrations at 0-h (31%;  $\pm 29\%$ ) and 48-h (32%;  $\pm 29\%$ ) relative to baseline, but decreased IL-6 at 24-h relative to post-exercise (-20%;  $\pm 18\%$ ). Conclusions. Oral curcumin likely reduces pain associated with DOMS with some evidence for enhanced recovery of muscle performance. Further study is required on mechanisms and translational effects on sport or vocational performance.

### COMPLEX SPORTS DRINK ENHANCES RECOVERY FROM PLYOMETRIC EXERCISE

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**Introduction** Post-exercise nutrients timing and selection are essential for glycogen replenishment, muscle protein synthesis and performance recovery (Manninen A., 2006). This study examined the effects of a complex sports drink beverage compared to placebo on recovery from a plyometric and drop jump exercise training session. **Methods** In a randomized, double blind two-arm controlled trial, 19 male active subjects performed an exercise training session with drop-jumps and plyometric jumps, and then immediately drank a complex sports drink beverage (SPD, n=9) or isovolumetric non-caloric placebo (PLA, n=10). The complex sports drink beverage contained amino acids, whey, carbohydrates,  $\beta$ -hydroxy  $\beta$ -methylbutyrate (HMB), green tea extract, ginseng extract, vitamins and electrolytes. Jump performance, 20m sprint, perceived muscle soreness and blood creatine kinase concentration were assessed before the training session, immediately after and 1, 2, and 3 days post training. **Results** Overall ANOVA showed a significant time x group interaction for jump performance and perceived muscle soreness. Post-hoc analysis showed that jump performance was greater 24h after the exercise training session in the SPD group compared to placebo ( $p < 0.05$ ). Perceived muscle soreness was significantly lower in the SPD group 2 and 3 days following the exercise training session compared to placebo ( $p < 0.05$ ). There were no significant differences in the 20m sprint test and in blood creatine kinase concentration among groups. **Discussion** In conclusion, consuming a complex sports drink beverage immediately after plyometric and drop jump training session may offer a recovery advantage regarding jump performance and perceived muscle soreness. However, the complex sports drink failed to enhance recovery assessed by 20m sprint test and a muscle damage blood marker any differently than what was observed with a placebo drink. **References** Manninen A (2006). *Br J Sports Med* 40(11), 900-905. Contact [bargetto.maxime@gmail.com](mailto:bargetto.maxime@gmail.com)

### EFFECT OF FENUGREEK SEEDS DRIED POWDER ON GLYCOGEN RESYNTHESIS

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**1. Introduction** Exercise promotes the consumption of energy sources such as glycogen by mobilizing internal energy metabolism to the maximum and using and depleting the energy source (1). Fenugreek (*Trigonell foenum graecum*) is an annual plant from the family Leguminosae, cultivated in Mediterranean countries and India (2). The main component of this extract is the amino acid 4-hydroxyisoleucine in the form of fenugreek, which has been shown to influence the insulin cell-signaling pathway increasing glucose uptake in insulin sensitive tissues, along with the up-regulation of metabolic enzymes and increased muscle and liver glycogen storage (3). The study was designed to determine the effects of ingesting an oral supplement containing fenugreek seeds dried powder (*Trigonella foenum-graecum*) with a glucose beverage on rates of post-exercise muscle glycogen resynthesis in normoglycemic male endurance athletes. **2. Materials and methods** The research included 30 competitive male kayakers with an average age  $18.2 \pm 2.8$  years and body height  $170.2 \pm 6.7$ cm, body mass  $70.3 \pm 4.3$  kg, divided into 2 groups of 15 subjects. Subjects completed a 90-minute glycogen depletion by paddling on ergometer machines following a 12 hour overnight fast. Immediately after exercise and 2 hours after, the muscle biopsy was obtained from the vastus lateralis. After 4hrs exercise subjects received an oral dose of 2 g.kg BW(-1)dextrose (Glu) or 200 mg.kg(-1) Fenugreek supplement and the same oral dose of dextrose, with the third muscle biopsy. Post exercise muscle glycogen concentration was similar for both trials. **3. Results** The results showed a significant increase in glucose and insulin rate from time 0 throughout the 4-hour recovery period. Although there was no significantly increased on muscle glycogen concentration from immediately post exercise to 4 hr of recovery for both trials. This data demonstrates that when the fenugreek supplement is added to a high oral dose of dextrose, rates of post-exercise glycogen resynthesis are enhanced above the effect of dextrose alone. **4. Discussion:** Clinical studies conducted on the fenugreek seed Supplementary have shown 4-hydroxy Isoleucine Aminoacid (4-OH-Ile) in this supplement may increase glycogen synthesis levels. In conclusion, this Supplement may enhanced the carbohydrate loading. However further study is needed to elucidate the more exact mechanism of effect of the Fenugreek on exercise durability. **References:** 1. Grenhaff PL, Timmonns JA. 1998. Interaction between aerobic and anaerobic metabolism during intense muscle exercise. *Exer Sports Sci Rev* 26:1-30 2. Muralidha K, Narasimhamurthy S, Viswanatha S, Ramesh BS. 1999., Acute and subchronic toxicity assessment of debitterized fenugreek powder in the mouse and rat. *Food Chem Toxicol*, 37:831-838 3. Slivka D., Cuddy J, Hailes W., Harger S., Ruby B., 2007, The addition of fenugreek extract (*Trigonella foenum-graecum*) to glucose feeding increases muscle glycogen resynthesis after exercise., *Amino Acids*,35:439-444

## Mini-Orals

### MO-PM12 Health & Fitness: Ageing, Gender, Strength

#### DIFFERENCE IN DUAL-TASK PERFORMANCE BETWEEN FALLERS AND NON-FALLERS IN OLDER PEOPLE

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**Introduction** Approximately one third of the individuals aged 65 and over experiences falls at least once a year with serious injuries (Zijlstra et al., 2008). Recently, dual task paradigms were used to assess the risk of falling in older adults with contrasting results (Zijlstra et al., 2008). The aim of this cross-sectional study was to examine the difference on mobility tasks under single-task and dual cognitive-task conditions and the difference in dual-task cost (DTC) between fallers and non-fallers. **Methods** Seventy-four older adults (44 non-fallers, 30 fallers; mean age =  $72.63 \pm 5.57$  yrs) were enrolled in the study. Participants performed the Timed Up and Go Test (single-task) and

Timed Up and Go Test while counting backward 7 (dual cognitive-task conditions). A 2 X 2 repeated measure with between-factor History of falling (non-faller vs faller) and within-factor Tasks condition (single-task and dual cognitive-task) was performed to examine mobility performance differences between fallers and non-fallers. One-way ANOVA was conducted to assess the difference in DTC between fallers and non-fallers. The level of significance was set at  $p < .05$ . Results The repeated measure showed a statistically significant interaction between the History of falling and Tasks condition ( $F(1,72) = 6.399, p < .05$ ). Moreover, a significant difference between faller and non-faller older adults was observed ( $F(1,72) = 5.735, p < .05$ ), as well as a significant reduction in mobility performance in all two groups ( $F(1,72) = 132.687, p < .05$ ). One-way ANOVA showed a significant difference ( $F(1,72) = 4.758, p < .05$ ) in DTC ( $M = 37.8 \pm 27.0\%$  for fallers and  $M = 27 \pm 17.7\%$  for non-fallers). Discussion The results of this study underlined that an additional cognitive-task affected the mobility performance in older adults with history of fall as reported in literature (Springer et al., 2006). Specifically, a slower performance in mobility performance while counting backward was associated with recurrent falls (Shumway-Cook et al., 2000), suggesting that changes in mobility performance during dual tasks might be challenging for fallers (Beauchet et al., 2008). References Beauchet O, Annweiler C, Allali G, Berrut G, Herrmann FR, Dubost, V. (2008). *J Am Geriatr Soc*, 56(7), 1265-1269. Springer S, Giladi N, Peretz C, Yogev G, Simon ES, Hausdorff JM. (2006). *MovDisord*, 21(7), 950-957. Shumway-Cook A, Brauer S, Woollacott M. (2000). *Physical Therapy*, 80(9), 896-903. Zijlstra A, Ufkes, T, Skelton DA, Lundin-Olsson L, Zijlstra W. (2008). *Gerontology*, 54(1), 40-49. Contact paoloriccardo.brustio@unito.it

### DEVELOPMENT OF ADJUSTABLE RESISTANCE MECHANISM TO PHYSICAL FITNESS EQUIPMENT FOR ELDERLY IN NEIGHBORHOOD PARKS.

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An adjustable resistance mechanism has been developed to apply for upper limb outdoor fitness equipment. Together with "aging in place" policy, the older adult can be natural aging in the community, and independence, self-esteem and open living space can be created. This hydraulic damper resistance mechanism employed water instead of oil to avoid doing harm to the environment. The transmission cam driven damper piston moves up and down to adjust the resistance. The results reveal that under 30 rpm frequency, the developed adjustable resistance mechanism can produce 24.6 to 26.8 kg resistance. In contrast, the physical fitness equipment right now already established in parks for elderly can only produce 4.7 kg resistance. This new developed mechanism has more stimulation to Brachioradialis, Triceps Brachii muscle, and Trapezius, therefore active ageing can be achieved by promotion of physical fitness, muscle strength and cardiopulmonary function. The aim of this project is to design and develop the adjustable resistance physical fitness equipment for older adults, and provides a constant, regular and effective exercise in the neighborhood park.

### ASSOCIATION BETWEEN SEDENTARY BEHAVIOR AND HEALTH VARIABLES IN ACTIVE BRAZILIAN ELDERLY

Nakamura, P., Sposito, L.A.C., Silva, T.F., Carvalho, D.M., Ferreira, A., Reis, S.A.M., Freitas, W.Z., Silva, E.

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Introduction Sedentary behavior has received widespread scientific attention in recent years. Several recent studies showing associations between sedentary behavior and all-cause mortality and other outcomes (Thorp et al., 2011). Therefore, the aim of this study was to analyse the association between sedentary behavior and variables health in active Brazilian elderly. Methods The sample was 24 active elderly women ( $67 \pm 5.2$  years) from "Projeto Pró-Saúde" (Project Pro-Health) of the Federal Institute of Education, Science and Technology, Muzambinho, MG, Brazil. The project occurs three times a week with 60 min of duration. All participants answered the following questionnaires: a) Sedentary Behavior Questionnaire (Mielke et al., 2013); b) Lifestyle profile (Quality of life) (Nahas et al., 2000). The anthropometric variables (Body Mass Index-BMI), waist hip ratio-WHR, % of fat and visceral fat were evaluated through bioimpedance (InBody 720). The Pearson analysis was used to verify the association between time of TV and time of sedentary transport (TST) and quality of life domains. Further, the Anova linear trend was used to verify the association between time of TV (0 to 180 min and >180 min) and TST (0 to 30 min and >30 min) with anthropometric variables. All analysis were performed through Stata 12.0. Results The time of TV showed a negative correlation with prevent domain of Quality of life ( $r = -0.42, p=0.04$ ). Only TST was positive associated with anthropometric variables. The TST increase 6.53 min/day ( $p=0.03$ ), 10.65 min/day ( $p=0.04$ ) and 36.46 min/day ( $p=0.03$ ) when occurs shift of category to BMI, % of fat and visceral fat, respectively. Discussion The results showed negative association between time of TV and Quality of Life and positive association between TST and anthropometric variables in active Brazilian elderly. Thus, even the participants being active, it was not enough to prevent against the harm of sedentary behavior. References Mielke G, Silva ICM, Owen N, Hallal PC. Brazilian adults' sedentary behaviors by life domain: population-based study. *PLoS ONE* 9(3) Nahas M, Barros MG, Franca V. Conceptual basis for a simplified wellness assessment instrument. *Brazilian Journal of Physical Activity and Health*. 2000; 5:48-59. Thorp AA, Owen N, Neuhaus M, Dunstan DW. Sedentary behaviors and subsequent health outcomes in adults: a systematic review of longitudinal studies. *Am J Prev Med*. 1996-2011; 41: 207-215. Contact pri\_nakamura@yahoo.com.br

### DIET AND FAST WALKING-BASED INTERVENTION TO TREAT OBESITY AND IMPROVE CARDIO-RESPIRATORY FITNESS

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Introduction: Positive effects of endurance training in the treatment of overweight and obesity are well known. Previous research has shown that fast walking close to preferred transition speed (PTS) can lead to significant weight loss in overweight and obese subjects [1]. However, the effect of this type of training on maximal oxygen uptake ( $VO_{2max}$ ) in overweight and obese is still unknown. The purpose of the current pilot study was therefore to test if fast walking close to PTS would aid in weight loss, improve cardio-respiratory fitness and has favorable effects on overall health status of overweight and obese individuals. Methods: The study included eight middle aged overweight and obese women (age: 30-50 yrs.; BMI:  $29.8 \pm 3.3$  kg/m<sup>2</sup>). Body composition, measured by bioelectrical impedance, body height (cm), body mass (kg), waist circumference (cm), resting heart rate (bpm), blood pressure (mmHg) and  $VO_{2max}$  ( $ml \cdot kg^{-1} \cdot min^{-1}$ ) were measured at baseline and following 16 weeks of training program. Exercise was performed 3 days/week consisting 40 minutes of fast walking close to PTS. Subjects followed a moderate diet (1200-1500 kcal/day) based on recommendations for weight loss in obese adults [2]. Results: A paired t-test revealed significant reductions in body weight ( $-15.3 \pm 4.1$  kg;  $p < 0.001$ ), BMI ( $-5.3 \pm 1.2$ ;  $p < 0.001$ ), fat mass ( $-14.5 \pm 3.7$  kg;  $p < 0.001$ ), waist circumference ( $-16.1 \pm 4.7$  cm;  $p < 0.001$ ), systolic blood pressure ( $-8.3 \pm 4.5$  mmHg;  $p = 0.001$ ), diastolic blood pressure ( $-5.9 \pm 2.8$  mmHg;  $p = 0.001$ ) and resting heart rate ( $-8.5 \pm 3.5$  bpm;  $p < 0.001$ ). Over the same period  $VO_{2max}$  improved significantly ( $11.5 \pm 1.6$   $ml \cdot kg^{-1} \cdot min^{-1}$ ;  $p < 0.001$ ). Discussion: Our preliminary findings suggest that fast walking close to PTS along with moderate diet

can substantially lower body weight, body fat and waist circumference and has positive effects on several other health aspects of overweight and obese individuals. Additionally, the training protocol has demonstrated to be strenuous enough to improve endurance performance. Nonetheless, trials with larger sample sizes and different exercise modalities may be needed to confirm these findings. References: [1] Ilic, D., et al. (2012). Walking at Speeds Close to the Preferred Transition Speed as an Approach to Obesity Treatment. *Srpski arhiv za celokupno lekarstvo*, 140(1-2), 58-64. [2] Jensen, M. D, et al. (2013). AHA/ACC/TOS Guideline for the Management of Overweight and Obesity in Adults. *J Am Coll Cardiol*. 63(25\_PA), 2985-3023. Contact pascal.bauer@univie.ac.at

### **A TAILORED SUPERVISED EXERCISE PROGRAM REDUCES LOSS OF FAT-FREE MASS IN BARIATRIC SURGERY PATIENTS**

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**INTRODUCTION** Although the beneficial effects on bariatric surgery (BS) on weight loss in the short term are widely proved, the exercise effects on patients who have gone through BS have been less studied. The objective of the current study is to know the effects of a tailored supervised exercise program on the subject's anthropometrical variables, in recently BS operated patients. **MATERIALS AND METHODS** After signing an informed consent, 33 Caucasian adult BS operated patients were included and distributed in two groups: a) an experimental group (GE, n=17), and b) a control group (CG, n=16). The EG realized a 6 months tailored supervised exercise program, while the CG followed the general lifestyle recommendations for BS patients. Three evaluations were performed: a) after the first month of BS (E1); b) once the exercise program had finished (E2); and c) six months after the end of the intervention (E3). "Post hoc", the EG subjects were divided on 2 subgroups: the one that did more than 50% of the scheduled sessions (EG1) and a second subgroup that did less than 50% of the sessions (EG2). **RESULTS** In comparison with E1, at E2 the EG kept the fat free mass (FFM, 54.4 vs 53.8 kg, p=0.406), while the CG significantly lost it (58.3 vs 55.2 kg, p=0.006). Correlations between weight at the end of the program and minutes of aerobic completed activity were found (r=0.517; p=0.049). On the other hand, the EG1 had a higher loss of fat mass than the CG (12.5 vs 8.9, effect size=0.67). At E3, six months after ending the intervention, the EG had a significant loss of FFM in comparison with E2 (53.8 vs 51.8 kg, p=0.002). **DISCUSSION** Bariatric surgery generates great reductions of corporal weight of BS patients (Moya et al., 2014), that can be accompanied by significant loss of FFM (Chaston, Dixon, & O'Brien, 2007). In our study, the tailored supervised exercise program prevented the FFM loss in the EG. However, once the training ceased, the EG showed a significant reduction of the FFM. Because of this, it can be suggested that the strength training during the exercise program could explain this observation. On the other hand, the volume of aerobic exercise seems to influence the weight loss. **REFERENCES** Chaston, T. B., Dixon, J. B., & O'Brien, P. E. (2007). Changes in fat-free mass during significant weight loss: a systematic review. *International Journal of Obesity*, 31(5), 743-50. Moya, M., et al (2014). Bariatric surgery, weight loss and the role of physical activity: a systematic review. *European Journal of Human Movement*, 32, 145-60.

### **KOREA YOUTH FITNESS CRITERION FOR OBESITY PREVENTION**

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**Introduction** That there is a negative relationship between obesity and physical fitness is well known through several researches (Laurson, K. et al, 2011; Liao, Y. et al, 2013; Welk, G. et al, 2011). It was needed to address the minimum fitness level required to prevent obesity for Korean youth. Therefore, the purpose of this study was to set a fitness absolute evaluation criteria for youth to conform to the standards of the Korea Youth Obesity established by empirical evidence in 2013 and to verify the validity and effectiveness. **Methods** Using an established adolescent obesity criteria based on 2013 results and 3938 adolescence fitness values involved in the national physical fitness 100 project, it was carried out difference analysis and receiver operating characteristic (ROC) between the normal group and the obese group. In accordance with this result, it was presented as minimum required fitness standards by genders and age for preventing overweight of Korean adolescents. The validity and effectiveness was analysed in physical standards set for each criterion of obesity; body fat rate, skinfold sum, and the waist. **Results** There is a significant difference between the normal group and the obese group in 20m round run, the maximum grip strength, relative grip strength, sit-ups, and repeated jump in male. In conclusion, absolute evaluation criterion of cardiorespiratory endurance, muscular strength and endurance are useful for obesity prevention. For female, it is reasonable to utilize the absolute criteria of only cardiorespiratory endurance and strength for obesity prevention. 20m round run, the maximum grip strength, and relative grip strength have shown significant difference between the normal group and the obese group. **Discussion** Physical fitness criteria established in this study will be able to be used as a criterion of the minimum strength for juvenile obesity prevention. Criterion considering the validity or maximum efficacy will be selectively used according to the purpose. In other words, if you only consider validity you can choose the high relationship between absolute valuation of obesity and physical variables. Or another variable can be chosen if the impact of maximum utility is more important than that the social impact of misclassification wrong to classify obesity as normal or the relative impact of what well to classify obesity as obese could be the reference value selected. **References** Laurson, K., Eisenmann, J., & Welk, G. (2011). Development of youth percent body fat standards using receiver operating characteristic curves. *American Journal Of Preventive Medicine*, 41(4 Suppl 2), S93-S99. Liao, Y., Welk, G., Going, S., Morrow, J., & Meredith, M. (2011b). Development of new criterion-referenced fitness standards in the FITNESSGRAM® program: rationale and conceptual overview. *American Journal of Preventive Medicine*, 41(4 Suppl 2), S63-S67. Contact bgko@sports.re.kr

### **MORNINGNESS AND EVENINGNESS IN MAXIMAL STRENGTH PERFORMANCE**

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**1: Department of Biology of Physical Activity, University of Jyväskylä, Finland 2: Faculty of Physical Education and Sport, Comenius University, Slovakia** **Introduction** It has been clearly established that maximal voluntary force varies during the day in human muscles (e.g. Sedliak et al., 2008) but the exact mechanisms behind the diurnal rhythms are still unclear. The aim of this study was to examine the diurnal rhythms in maximal isometric force production in a larger group of subjects and also by separating the morning types and evening types based on their maximal force levels. **Methods** 72 men were measured in the morning (6:00-10:00) and in the evening (16:00-20:00) for maximal bilateral isometric leg press force (MVCLP) together with myoelectric activity (EMGLP), maximal unilateral isometric knee extension force (MVCKE) and maximal voluntary activation level (VA%) during maximal unilateral isometric knee extension force (MVCVA) to-

gether with myoelectric activity (EMGVA). Morning (n=8) and evening types (n=19) were separated from the large group based on the mean morning/evening difference in MVCLP and MVCKE. Results In the total group of subjects MVCLP and MVCKE were  $4.4 \pm 12.9\%$  ( $p < 0.01$ ) and  $4.3 \pm 10.6\%$  ( $p < 0.01$ ) higher in the evening compared to the morning. MVCVA and VA% did not show significant diurnal variation. The morning types showed 6-11% ( $p < 0.05$ ) higher force values in the morning for MVCLP and MVCKE. No significant diurnal variation was observed for MVCVA and VA%. The evening types showed 14-16% ( $p < 0.05$ ) higher force values in the evening with a concomitant higher VA% in the evening ( $p < 0.05$ ). EMGLP and EMGVA did not show significant diurnal fluctuations in any group. Between-group differences were observed for MVCLP ( $p < 0.001$ ), MVCKE ( $p < 0.001$ ) and EMGVA ( $p < 0.05$ ). Discussion In the total group of subjects our results were consistent with previous studies (e.g. Sedliak et al., 2008) as force was higher in the evening compared to the morning. Lack of diurnal rhythms in EMG and VA% suggest that peripheral rather than central mechanisms could explain the morning to evening variation in force production. However, diurnal variations in strength performance seem to be multi-factorial and mechanisms behind the rhythms seem to vary between the individuals (Chtourou & Souissi 2012). Higher evening force values observed in the present evening type group could be partly explained by increased central nervous system drive to the thigh muscles as VA% was also higher in the evening. It seems that in the morning types peripheral factors affect diurnal variations as central mechanisms did not show any time of day effect. However, the exact mechanisms still need further investigation. References Chtourou H & Souissi N (2012). J Strength Cond Res 26: 1984-2005. Sedliak M, Finni T, Cheng S, et al (2008). Int J Sports Med, 29(3):217-24.

### THE ACUTE EFFECT OF THREE DIFFERENT WARM-UP TYPES IN THE ELBOW MAXIMUM ISOMETRIC STRENGTH

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Introduction: Warm-up such as static stretch and jogging usually used to prevent injuries before exercise. Previous study indicated that long-term whole body vibration (WBV) training could improve muscle strength (Verschuere et al. 2005). However, few studies discuss the effect of vibration in upper extremity and as a warm-up. Therefore, the aim of this study was to investigate the acute effect of vibration in upper extremity, static stretch and jogging in elbow maximum flexion strength. Methods: Six healthy males with physically active (age :  $21.5 \pm 1.1$  years, height:  $169.3 \pm 7.3$  cm, weight:  $68.3 \pm 8.9$  kg) participated in this randomized cross-over trial. All participants received three warm-up programs (vibration, static stretch, and jogging). The subject received vibration at modified push-up posture with the amplitude 2 mm and frequency 30 Hz by 1 minute vibration with 30 seconds rest for three sets. The biceps stretch 30 seconds with 30 seconds rest for three sets as static stretch while jogging was running for three minutes at 8 m/sec. The isometric elbow flexion strength was measured by the dynamometer before and just after three types of warm-up. One-way ANOVA was used to analyze the differences of muscle strength change before and after warm-up between three warm-up programs. Result: There was also no significant difference between pre-test muscle strength and post-test muscle strength in three kinds of warm-up programs vibration, static stretch, and jogging programs ( $p = 0.204$ ,  $p = 0.113$ ,  $p = 0.921$ , respectively). The maximal muscle strength before and after warm up programs were static stretch (pre-test:  $52.7 \pm 11.2$ , post-test:  $50.8 \pm 10.6$  N-m), vibration (pre-test:  $54.1 \pm 12.7$ , post-test:  $56.4 \pm 14.2$  N-m) and jogging (pre-test:  $51.8 \pm 10.7$ , post-test:  $51.6 \pm 7.9$  N-m). Discussion: In this study, the results showed that the elbow maximum flexion strength was not changed after three types of warm-up. Previous study had shown that static stretch may decrease muscle power and performance (Behm et al., 2001), that is not consistent with study. Different stretch muscle may have various effects. Previous study demonstrated lower frequency WBV (20 Hz) would enhance jump height, but showed contrast results in high frequency WBV (40 Hz) (Cardinale et al., 2003). Different vibration amplitude, frequency and training target may also influence the results. From this study, using the vibration, static stretching and jogging as warm-up may not change the muscle strength of upper extremity. Reference Verschuere SM, Roelants M, Delecluse C, Swinnen S, Vanderschuere D, Boonen S. (2004). J Bone Miner Res, 19, 352-359. Behm DG, Button, DC, Butt JC (2001). Can J Appl Physiol, 26(3), 261-272. Cardinale M., Lim J. (2003) Medicina Dello Sport, 56(4), 287-292. Contact j2j721836@hotmail.com.tw

### EATING DISORDERS AND MENSTRUAL IRREGULARITIES AMONG FEMALE FOOTBALL PLAYERS IN HUNGARY

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Introduction: Numerous publications suggest the connection between eating disorders (ED) and sport (Sundgot-Borgen, 2007). Risk factors include restrained eating and training, frequent weight cycling, early sport-specific training, personality factors, injury, a sudden increase in training volume and the impact of coaching behaviour. A number of factors, such as energy balance, EDs, exercise intensity and training practices, body weight and body composition, and physical and emotional stress, may contribute to the development of athletic menstrual dysfunction (MD) (Sundgot-Borgen, 2007). Aims: In the present study the occurrence of ED and MD was examined among physically inactive women (C) [n=65] and elite female football players (FP) [n=65] in Hungary. Methods: ED was investigated by EDI (Garner, 1983) and SCOFF (Morgat, 1999) tests. MD was measured by questions on menstrual history. Statistics: Bonferroni-test, Mann-Whitney U-test. Results: The first three subscales of EDI are capable to detect ED. Although there were a few participants in both groups whose scores reached the critical limits in 'Drive for Thinness' (C: 4.61%; FP: 6.15%) and 'Body Dissatisfaction' (C: 3.08%; FP: 4.61%) subscales, there were no significant differences between the rates. None of the participants of both groups passed the critical limit in the 'Bulimia' subscale. There was no significant difference between the average scores of first three subscales of EDI in the two groups. The next five subscales of EDI measure psychopathology commonly associated with, but not unique to, ED. We could observe significant difference only between the average score of 'Interpersonal Distrust' (C:  $2.4 \pm 0.39$ ; FP:  $3.75 \pm 0.46^{**}$ ). Depending on the SCOFF-test we could not observe any significant difference between the incidence of EDs in the groups (C: 16.92%; FP: 12.31%). We could not detect primary amenorrhea among the participants. In the FP group the menarche age was significantly older (C:  $12.9 \pm 0.17$  yrs; FP:  $13.81 \pm 0.2$  yrs\*\*\*). Less FPs had oligomenorrhea (C: 36.92%; FP: 13.85%), but there was no significant difference between the rate of secondary amenorrhea (C: 10.77%; FP: 3.08%). The common incidence of EDs and MDs was the same in both groups (C: 7.69%; FP: 7.69%). Conclusion: We could detect a few differences between the incidence of MDs and the 'Interpersonal Distrust' was higher in FP group, but these results suggest that there is no significant difference between the common incidences of these problems among the investigated groups. References: Morgan JF et al. (1999). BMJ, 319, 1467-1468. Garner DM et al. (1983) Int J Eat Disord, 2, 15-34. Sundgot-Borgen J et al. (2007) Br J Sports Med. 1, 168-72.



## A RESEARCH INTO THE EFFECT OF DIFFERENT EXERCISE TYPES ON ECHOCARDIOGRAPHY AND SOME BLOOD PARAMETERS IN SEDENTARY WOMEN

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Introduction: Lipid and lipoprotein abnormalities play a major role in the development and progression of coronary artery disease. In this survey, it was aimed to search the impact of aerobic-step and core exercises on echocardiography and blood parameters in sedentary women. Methods : 45 voluntary women (aerobic-step (n=25) and core exercise group n=20) at the age of between 25 and 45 participated in the study. Two different exercises were applied to these women for 4 days a week, throughout 16 weeks, within 60 minutes for each exercise with the intensity of 60-70 percent. The physical and physiological characteristics, echocardiography and some blood parameters of the women were measured before and after the exercise. Paired Samples-t test and Independent-Samples- t test were used for statistical analysis. Results: Following the exercise programme, there is a meaningful decrease in the body weight, BMI, fat mass, value of waist region and hip circumference of the women as well as in the values of glucose, creatinin, total cholesterol, LDL-K averages and hs-CRP and Hcy ( $p<0,05$  and  $p<0,01$ ). In addition, it has been found that the values of VO<sub>2</sub>Max in both exercise groups increased, that the functions of left ventricular systolic meaningfully improved. The left ventricular diastolic functions of the aerobic-step group improved more. Discussion: It is widely accepted that exercise affects blood cholesterol and other lipids in a positive way, by regulating the metabolism of all lipids in the blood (Kokkinos and et al. 1995). With regular and prolonged exercise, the heart undergoes changes. These changes constitute the cardiac adaptability in response to physical training or some physiological causes. Several studies have shown that structural and functional changes in the left ventricle during exercise are greater than in other parts of the heart (Hosseini and et al. 2012; Middleton and et al. 2006). According to the result of the study , the decrease in the inflammatory markers of hs-CRP and Hcy and echocardiographic results along with the increase in VO<sub>2</sub>Max and the decrease in LDL stemming from the exercise have revealed that both two exercise types can be effectively used in order to improve physical fitness of sedentary women. References: 1.Kokkinos PF, Holland JC, Narayan P, et al. Miles run per week and high-density lipoprotein cholesterol levels in healthy, middle-aged men. A doseresponse relationship Arch Intern Med 1995, 155:415-420. 3.Hosseini M., Piri M., Agha-Alinejad H., Haj-Sadeghi Sh. The effect of endurance, resistance and concurrent training on the heart structure of female students. Biol. Sport 2012;29:17-21. 4.Middleton N., Shave R., George K., Whyte G., Hart E., Atkinson G. Left ventricular function immediately following prolonged exercise: A meta-analysis. Med. Sci. Sports Exerc. 2006;38:681-687.

## Mini-Orals

### MO-BN07 Cognitive impairments and fatigue during exercise

#### MENTAL EXERTION DOES NOT AFFECT ELITE CYCLISTS

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Introduction: Mental fatigue (MF) increases perceived exertion (RPE) and impairs endurance performance in recreationally-trained athletes (Marcora 2009; Pageaux 2014). The effect of MF on elite athletes is unknown. The aim of the study was to assess the performance, physiological and psychological responses of elite cyclists following a bout of mental exertion. Methods: Nine elite road cyclists completed 30 min of an incongruent Stroop colour-word task, previously used to induce MF in recreational runners (Pageaux 2014), or 30 min of a passive control task in a double blind cross-over study. Following each treatment, participants completed a standardised warm-up and a 20 min cycling time trial (TT). Performance, physiological and psychological measures were recorded throughout the Stroop task and TT. Results: The Stroop task was rated as more mentally demanding ( $p<0.001$ ), requiring more effort ( $p<0.001$ ) and eliciting greater subjective ratings of fatigue ( $p=0.005$ ) than the control task. Blood glucose concentration tended to increase throughout the Stroop task ( $p=0.053$ ). During the TT, there was no difference between conditions for mean power ( $p=0.983$ ), total distance covered ( $p=0.491$ ) or pacing profile ( $p=0.777$ ). RPE increased over time ( $p<0.001$ ) but was identical between conditions ( $p=1.00$ ). Discussion: Mental exertion did not affect RPE or TT performance in elite cyclists. These findings contrast those observed in recreational athletes (Pageaux 2014). The negative impact of MF on endurance performance has been attributed to an accumulation of adenosine in the anterior cingulate cortex, the primary sensory input for RPE (Pageaux 2014). Adenosine accumulates under periods of increased energy demand and reduced energy availability. Training-induced increases in basal cerebral glycogen levels have been observed in rats following 4 weeks of endurance training (Matsui 2012). A similar adaptation in the elite cyclists would subsequently minimise adenosine accumulation and disruption to RPE and performance. In support of this hypothesis, blood glucose concentration in this study tended to increase throughout the Stroop task, also in contrast to findings in recreational athletes (Marcora 2009; Pageaux 2014). Elite athletes therefore may possess training-induced adaptations and experience which afford them the ability to reproduce exercise performance following mental exertion. References: Marcora S, Staiano W, Manning V. (2009). J Appl Physiol, 106, 857-64 Pageaux B, Lepers R, Dietz K, Marcora S. (2014). Eur J Appl Physiol, 114, 1-11 Matsui T, Ishikawa T, Ito H, Okamoto M, Inoue K, Lee M, et al. J Physiol. (2012). 590, 607-16 Contact: kristy.martin@canberra.edu.au

#### ADAPTATION OF LEG EXTENSOR MUSCLE ACTIVITY TO REPEATED MAXIMAL CONTRACTIONS

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Introduction Rapid knee extension is crucial for support and movement of the body in various physical activities. Knee extension is closely related to performance so it is necessary to repeatedly perform this motion as long and stably as possible. The preparatory process for force generation with proper timing is vital for both voluntary and reflex behavior. This study was designed to investigate how the vastus lateralis (VL) and medialis (VM) muscles are activated to prevent the decline in knee extension force during prolonged repetition and whether prediction of the correct timing to exert force influences muscle activation patterns. Methods Fifteen male subjects performed 100 isokinetic extensions (90°/s) with 50 performed at maximal voluntary contraction (MVC) cued by a light at 60° knee angle. In condition 1 (C1), MVC was performed on every second trial (50 in total), while in C2, the 50 MVC trials were randomly interspersed. In addition, only in C1 were subjects informed beforehand of the light cue timing. Electromyographic (EMG) activity from VL/VM, knee joint angle, and knee

joint torque (KJT) were recorded. After each measurement, the subjects rated the degree of muscle fatigue. After the experiment, subjects graded the force and timing of MVC performance for repetitions 1–10, 21–30, and 41–50 on a scale of 1 to 5. Results In C1, EMG pre-activity from VL and VM increased significantly with the number of MVC repetitions while latencies decreased, and there were strongly negative exponential relationships between pre-activities and latencies. Similar results were not observed in C2. Electromechanical delay (EMD) remained unchanged during repetition both in C1 and C2. Maximum KJT showed no significant changes with repetition but was uniformly larger in C1. The EMG burst induced by MVC was occasionally preceded by a tiny EMG burst, which was more frequent in C1 than C2. There were no significant differences in the self-evaluation of MVC performance between C1 and C2, but self-evaluation of timing significantly improved with the number of repetitions in C1 but not C2. However, a significantly greater degree of fatigue was reported in C1. Discussion Pre-activity induced by a cue for predicting the timing of MVC reduced reaction time and compensated for the decline in muscle function during MVC repetition, although fatigue increased. Extending the knee joint passively increases VL and VM slack. Pre-activity may have reduced the stimulus-response delay by compensating for this muscle slack beforehand, resulting in higher peak KJT. References Ogiso K, McBride JM, Finni T, Komi PV. (2002). *J Electromyogr Kinesiol*, 12, 27–36.

## CHANGES IN MAGNITUDE AND ORIGIN OF FATIGUE DURING REPEATED MAXIMAL KNEE EXTENSIONS

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**Introduction** Many sports require athletes to produce repeated maximal contractions. Previous results suggest that maximal contractions completed at high velocities lead to a rapid and higher level of peripheral fatigue, whereas at low contraction velocities central fatigue develops progressively [2, 3]. This study investigated changes in the magnitude and origin of fatigue observed during the repetition of maximal knee extensions (KEXT) performed at a very low contraction velocity (15°/s) and with a large work to rest ratio (4.6s/1.4s). **Methods** Seven active subjects performed 120 KEXT on an isokinetic dynamometer. Electromyography activity was recorded from vastus lateralis muscle. Torque, electromyography amplitude (EMG), median frequency (MF) and EMG/torque ratio were extracted every 30 repetitions (R1-R30-R60-R90-R120). Neuromuscular testing (NMT) was administered at baseline and immediately following each 30 repetitions to extract maximal voluntary torque (MVT), voluntary activation (VA), potentiated quadriceps twitch (Qtw), maximal M-wave amplitude (MMAX), and EMG/MMAX. One-way ANOVA evaluated the effect of repetition on changes in KEXT and NMT variables ( $P < 0.05$ ). Results MF decreased (R1:  $62 \pm 7$ ; R30:  $56 \pm 6$  Hz) and EMG/torque increased (R1:  $0.6 \pm 0.2$ ; R30:  $1.1 \pm 0.4$ ) at R30; torque (R30:  $53 \pm 8$ ; R60:  $60 \pm 7$ ; R90:  $62 \pm 9$  %) and EMG (R30:  $22 \pm 5$ ; R60:  $27 \pm 8$ ; R90:  $33 \pm 7$  %) decreased until R90 (all  $P < 0.05$ ). MVT was lower after each 30 repetitions (R30:  $28 \pm 16$ ; R60:  $37 \pm 25$ ; R90:  $41 \pm 25$ ; R120:  $48 \pm 26$  %;  $P < 0.05$ ). Qtw reduced at R30 ( $41 \pm 21$  %); VA decreased after R60 (R60:  $22 \pm 18$ ; R90:  $29 \pm 17$ ; R120:  $38 \pm 21$  %;  $P < 0.05$ ); EMG/MMAX was lower after R30 and R120 (R1:  $0.06 \pm 0.02$ ; R30:  $0.044 \pm 0.01$ ; R120:  $0.037 \pm 0.01$ ) (all  $P < 0.05$ ). MMAX did not change ( $P = 0.7$ ). **Discussion** We observed faster and more pronounced reductions in knee extensor torque during KEXT which was associated with greater variations in peripheral and central fatigue indicators when compared to previously reported results for comparable exercise protocols [2, 3]. An early development of peripheral fatigue was evidenced by a reduction in Qtw and MF, associated to an increase in EMG/torque; presumably in response to an increase in metabolic perturbations caused by the repetition of maximal contractions. A delayed onset of central fatigue was identified by a decrease in VA, likely resulting from peripheral fatigue and an increase in group III/IV afferent feedback leading to reduced neural drive and motoneuronal excitability [1], as suggested by the decreases in EMG and EMG/MMAX. 1. Amann, et al., *J Appl Physiol*, 2013. 115(3): p. 355–364 2. Babault, et al., *J Appl Physiol*, 2006. 100(3): p. 780–785 3. Morel, et al., *Scand J Med Sci Sports*, 2014 DOI: 10.1111/sms.12358 Contact david.rouffet@vu.edu.au

## IS PERCEPTION OF EFFORT IMPACTED BY ELECTROMYOSTIMULATION DURING MUSCLE CONTRACTION?

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**INTRODUCTION** Perception of effort defined as “the conscious sensation of how hard, heavy and strenuous a physical task is”, plays an important role in the regulation of exercise performance (Pageaux, 2014) and is well used for exercise prescription (Marcora, 2010). However, its neurophysiology is poorly understood. To date, the two main models of perception of effort generation are the corollary discharge (CD) model and the afferent feedback (AF) model. In the present study, we investigated the validity of these models using electromyostimulation (EMS) to manipulate the magnitude of central motor command/CD and AF during voluntary (V), evoked (EMS) and combined (V+EMS) contractions at same force output. We hypothesised that perception of effort would reflect the magnitude of the central motor command/CD, independently of AF stimulated by EMS. **METHODS** Ten subjects with previous experience of EMS volunteered in this study. V, EMS and V+EMS contractions were performed during isotonic (5% and 20% maximal voluntary contraction, MVC) and isometric contractions (10 and 20% MVC). Subjects were asked to report perception of effort, perceived force and muscle pain for each contraction. **RESULTS** For the same force output, subjects reported effort only during voluntary contractions. The effort was perceived lower (isometric:  $P=0.036$ ,  $d_z=1.062$ ; isotonic:  $P<0.001$ ,  $d_z=1.725$ ) during combined contractions (low central motor command/CD) than during voluntary contractions (full central motor command/CD). Contrary to perception of effort, subjects perceived the force during all kind of contractions. Muscle pain was higher during EMS than during voluntary contractions ( $P<0.05$ ). **DISCUSSION** Subjects rated independently perception of effort, perceived force and muscle pain. The ability of the subjects to perceive force and muscle pain during evoked contraction confirms that AF contributes to these sensations during evoked and combined contractions. The lower perception of effort during the combined contraction (low central motor command/CD and higher AF) compared to voluntary contraction (full motor command/CD and lower AF) supports the hypothesis that AF is not the sensory signal generating perception of effort. These findings provide further support in favour of the proposal that perception of effort is generated by neurocognitive processing of CD, i.e. efferent copies of the central motor command. **REFERENCES** Marcora, S.M. (2010) Effort: perception of. In EB, G. (ed) *Encyclopedia of Perception*. SAGE Publications Inc., Thousand Oaks, pp. 380–383. Pageaux, B. (2014) The psychobiological model of endurance performance: an effort-based decision-making theory to explain self-paced endurance performance. *Sports Med*, 44, 1319–1320.

## BENEFITS OF HIGH INTENSITY INTERVAL TRAINING FOR ENHANCING HIPPOCAMPUS-DEPENDENT SPATIAL LEARNING AND MEMORY

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**Introduction** Exercise has beneficial effects on hippocampal-related learning and memory. However, the optimum exercise condition for such effects remains controversial. Recently, it has been reported that high-intensity interval training (HIT) is more effective for improving aerobic capacity than is endurance training (ET) (Gibala et al., 2006). Moreover, we have also found that intermittent and high-intensity of voluntary resistance-wheel running enhances spatial memory (Lee et al., 2012). These results lead us to hypothesize that HIT should improve learning and/or memory based on the possible mechanisms underlying hippocampal BDNF signaling through its receptor (TrkB). We thus aimed to clarify whether HIT effectively enhances hippocampal-related spatial learning and memory compared with ET. **Methods** Male Wistar rats (10 weeks old) were separated into three groups: HIT (n=10), ET (n=10), and sedentary control (n=8). The rats were trained for four consecutive weeks with five sessions per week. HIT consisted of ten 30-sec bouts of exercise, interspaced with 2.5 min of recovery. The initial treadmill speed was 30-40 m/min for the first week and the speed was increased gradually to 60 m/min by the final week. ET consisted of 30 min of continuous running at 20 m/min. The ratios of HIT to ET were 1:6 for exercise time and 1:2~1:4 for exercise volume. We used Morris water maze (MWM) to evaluate spatial learning and memory. The protein levels of BDNF and TrkB, were detected using western blotting. **Results and Discussion** Muscular enlargement (soleus and plantaris) were found in both exercise groups, although body mass was slightly reduced which validate our HIT protocol as a resistance exercise. We also found that both HIT and ET groups had significantly enhanced spatial learning and memory compared to the control group; in particular, only the HIT group exhibited faster escape latency (acquisition of learning) compared to the control group in trials on day 2, but the percentage of time spent in the platform quadrant during the probe trial (memory of learning) significantly increased in both HIT and ET groups compared to the control group. Furthermore, the HIT group had significantly increased hippocampal TrkB protein, even though there was no difference in the hippocampal BDNF protein between groups. These results suggest that HIT protocol, which consists of a lower volume and shorter time of exercise compared to ET, is more effective for enhancing hippocampus-dependent learning and memory associated with hippocampal BDNF signaling. **References** Inoue et al., *Int J Sports Med.* In press. Gibala et al., *J Physiol*, 575, 901-911, 2006. Lee et al., *J Appl Physiol*, 113, 1260-1266, 2012.

## CENTRAL SENSORIMOTOR ACTIVATION DURING ECCENTRIC VS. CONCENTRIC QUADRICEPS FEMORIS CONTRACTIONS

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**INTRODUCTION:** Eccentric (ECC) and concentric (CON) contractions are widely thought to involve different neuromuscular activation strategies that result, at least in part, from central sensorimotor modulations. However, the underlying neuroelectric processes associated with different contraction types (i.e. ECC, CON) remain to be elucidated. **PURPOSE:** This study directly determined central sensorimotor activation during ECC and CON contractions at equivalent relative torques. **METHODS:** Following familiarization, maximum voluntary torques (MVTs) and associated EMG amplitudes were determined during three maximal isometric (ISO) contractions, and each phase of four reciprocal CON-ECC contractions ( $60^\circ \cdot s^{-1}$ , analyzed range of motion:  $29-101^\circ$ ). Thereafter 16 healthy males ( $24 \pm 5$  yrs,  $180 \pm 7$  cm,  $76 \pm 10$  kg) performed a cyclic series of 36 reciprocal CON-ECC contractions of the right quadriceps femoris, including 5 sets of 4 contractions at 25% and 4 sets of 4 contractions at 50% of CON MVT, with 60/90-s rest between sets. ECC and CON torque, quadriceps femoris EMG and EEG were recorded at rest and during all contractions. A 32-channel active-electrode cap collected EEG (entire frequency range of 0.5-50 Hz). Voxel-based standardized low-resolution brain electromagnetic tomography analysis (sLORETA) calculated cortical activation for the entire frequency range, as well as for the constituent frequency bands delta, theta, alpha, beta and gamma. **RESULTS:** Alpha (7-13 Hz) activation was greater in the sensorimotor cortex during ECC compared to CON contractions at both 25% (critical threshold (t-critical): 5.343,  $p < 0.01$ ) and 50% of MVT (t-critical: 4.755,  $p < 0.01$ ), but not within other cortical areas. Activation within the other frequency bands, or for the entire frequency range, was not modulated by contraction type. Peripheral neuromuscular activation (i.e. quadriceps femoris EMG amplitude) was lower during ECC compared to CON contractions at 25% ( $33.5 \pm 9.3$  vs.  $37.3 \pm 8.3$  %EMG@ISO\_MVT, paired t-test:  $p < 0.001$ ) and 50% of MVT ( $49.7 \pm 11.2$  vs.  $61.7 \pm 10.8$  %EMG@ISO\_MVT,  $p < 0.001$ ). **CONCLUSION:** Increased sensorimotor alpha activation was observed during ECC quadriceps femoris contractions, which may reflect central inhibitory processes compared to CON contractions. Supported by German Sport University Cologne grant HIFF92106.

## PERIPHERAL AND CENTRAL ADJUSTMENTS DIFFER BETWEEN PROXIMAL AND DISTAL MUSCLES OF THE UPPER LIMB DURING FATIGUE

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**Introduction.** Biomechanical and intrinsic characteristics of muscles involved in sustained contractions influence the time to failure (1). Whether or not muscles work synergistically within a muscle group (elbow flexor), as well as the characteristics of the neural activation should also modulate fatigability. For example, biceps brachii (BB) is characterized by a motor unit recruitment range up to 90% of the maximal voluntary contraction (MVC) force whereas it is limited to ~50% MVC in hand muscles (3). This should influence intramuscular pressure and metabolites accumulation during sustained contraction, inducing thereby distinct neural adjustments (2). To document the muscle-related aspects of fatigability, this study investigated peripheral and central adaptations during a submaximal voluntary contraction performed with either the elbow flexors or the abductor pollicis brevis (APB). **Methods.** 13 subjects sustained an isometric contraction until failure at 35% of MVC torque with either the elbow flexors or APB in separate sessions. Surface electromyography (EMG), motor evoked potentials (MEP) induced by transcranial magnetic stimulation, and muscle tissue oxygenation assessed by means of near infrared spectroscopy was recorded for BB and APB. MVC force was measured before the sustained contraction and at failure. **Results.** The time to task failure ( $p=0.19$ ) and the decrease in MVC force ( $p=0.99$ ) were similar in both muscle groups. During the sustained contractions, EMG did not vary significantly in APB (from  $51.3 \pm 15.1\%$  to  $58.3 \pm 16.7\%$  MVC;  $p=0.25$ ) but increased from  $29.8 \pm 10.3\%$  to  $60.0 \pm 25.4\%$  MVC;  $p < 0.001$ ) in BB. The MEP amplitude increased more in APB (+43%;  $p < 0.001$ ) than in BB (+15%;  $p=0.009$ ) whereas muscle tissue oxygenation decreased more in APB (-77%;  $p < 0.001$ ) than in BB (-8%,  $p=0.025$ ). **Discussion.** The higher initial EMG activity in APB likely reflects greater motor unit recruitment in APB (3), inducing more intramuscular pressure, and favoring thereby metabolites accumulation,

as suggested by the larger decrease in muscle oxygenation for this muscle. This should have increased spinal and supraspinal inhibitory mechanisms by group III/IV afferents, requiring a greater increase in descending drive to maintain motor output in APB, as suggested by the greater increase in MEP for this muscle. These results suggest that even though time to failure and decline in MVC force were similar between the two muscle groups, the mechanisms leading to task failure involve large differences in the extent of changes at the peripheral and central levels. References 1. Barry, Enoka (2007) *Integr Comp Biol* 47:465-73 2. Gandevia et al. (1996) *J Physiol* 490: 529-36 3. Kukulka, Clamann (1981) *Brain Res* 219: 45-55 Contact Achraf.Abdelmoula@ulb.ac.be

### THE EFFECT OF HIGH-INTENSITY INTERVAL EXERCISE AND MODERATE-INTENSITY CONTINUOUS EXERCISE ON EXECUTIVE FUNCTION IN POST-EXERCISE RECOVERY

Tsukamoto, H., Suga, T., Takenaka, S., Takeuchi, T., Tanaka, D., Hamaoka, T., Isaka, T., Hashimoto, T.  
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**Introduction** Cognitive executive function (CEF) is acutely improved by aerobic moderate-intensity continuous exercise (MCE) (Ogoh et al., 2014). On the other hand, high-intensity interval exercise (HIIE) more efficiently improves fitness level and protects against the risk factors of the metabolic syndrome than MCE (Tjønnå AE et al., 2008). However, the effect of HIIE on CEF is unclear. Furthermore, the effect of HIIE as well as MCE on CEF during post-exercise recovery also remains unknown. We hypothesized that HIIE could improve CEF more efficiently than MCE, and that improvement would be sustained longer following HIIE than MCE. To address these hypotheses, we aimed to examine the CEF following HIIE and MCE. **Methods** Twelve young healthy male subjects performed 2 aerobic exercises: MCE and HIIE. MCE condition was cycle ergometer exercise at 60% VO<sub>2</sub>max for 40 min. HIIE condition was cycle ergometer exercise at 60% and 90% VO<sub>2</sub>max for 17 min and 16 min, respectively: initially, 5 min of exercise at 60% VO<sub>2</sub>max, followed by 4 × 4 min of interval cycle ergometer exercise (4 min of exercise at 90% VO<sub>2</sub>max followed by 3 min of active resting at 60% VO<sub>2</sub>max). HIIE and MCE were same exercise volume. Subjects undertook a color-words Stroop task (CWST) at each of the examined time points (pre-exercise and post-exercise recovery at 0 min (immediate after the end of exercise), 10 min, 20 min and 30 min). **Results** The CEF as evaluated using a reverse-Stroop interference score in CWST was significantly improved at immediate after the end of either HIIE or MCE compared with pre-exercise ( $P < 0.01$ ), although there was no significant differences in CEF between 2 conditions. The improved CEF was sustained until 30 min following HIIE, while the improvement of CEF was diminished at 30 min following MCE. Interestingly, improved CEF at 30 min post-exercise recovery was correlated with augmented area under the curve of blood lactate concentration during the experimental periods ( $r = 0.57$ ,  $P < 0.01$ ). **Discussion** These results suggest that HIIE could improve CEF, and that improvement might be sustained longer following HIIE than MCE in young healthy subjects. HIIE-induced high blood lactate, which is an important energy source for the human brain (van Hall et al., 2009), may be involved in improved CEF even at 30 min post-exercise recovery. The present findings may provide an impetus to develop an optimum exercise method for the clinical treatment of CEF. **References** Ogoh S et al. (2014). *Physiol Rep*, 2(9), e12163. Tjønnå AE et al. (2008). *Circulation*, 118(4), 346-54. Van Hall G et al. (2009). *J Cereb Blood Flow Metab*, 29(6), 1121-1129. Contact Takeshi Hashimoto (t.hashimo@fc.ritsumei.ac.jp)

### MUSCLE ACTIVATION OF DIFFERENT PORTIONS OF THE TRICEPS BRACHII DURING EXERCISES WITH ELASTIC AND PULLEY

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**INTRODUCTION** The relative contribution of the two heads of the triceps brachii muscle (TB) is important to define training and rehabilitative protocols (1). Elastic band is a versatile and low-cost equipment, but it is not widely used as compared to machines (2). The purpose of this study is to evaluate the contribution of the long and lateral heads of the TB muscle during triceps pushdown (TP) and lying triceps extension (TL), with both imposed elastic resistance (ER) and constant resistance (CR). **METHODS** Eleven trained male volunteers (21.4 ± 2 yrs; 80.3 ± 11 kg; 177.3 ± 0.8 cm) were studied. Maximal voluntary isometric contraction (MVIC) was measured with elbow at 90° for both exercises. Participants performed one set of 10-12 repetitions for each condition. All conditions, which resulted in four sets, were randomly presented. The intensity chosen was 30% MVIC measured by a load cell. This intensity was set at the mid way of the excursion for ER. A custom made electrogoniometer was used to measure the joint angle. A metronome was used as a reference to keep the whole movement at 0,25Hz. The activity of the TB heads was measured using surface electrodes and an EMG system (sample: 2 kHz; cutoff frequency of the low-pass filter: 500Hz). The root mean square (RMS) was averaged throughout the repetitions. A 3 × 2 mixed factorial ANOVA was performed to detect possible differences and interactions among conditions with a significance level set at  $p < 0.05$ . **RESULTS** There was no difference in muscle activation between the heads of the TB ( $p = 0.178$ ) and between exercises ( $p = 0.05$ ). A significant difference was found between the types of equipment ( $p = 0.008$ ) with the CR presenting higher activation than ER. **DISCUSSION** Muscle activation during TP was higher than TL. However, this difference produced a marginal p-value. Thus, TL and TP are not able to isolate the TB heads. Interestingly, muscle activation was significantly greater in CR than ER. During CR, the greater the angle at the eccentric phase, the smaller the force required to overcome the resistance. The resistance varies according to the length (or joint angle) during ER (the higher the angle, the higher is the resistance). However, the force (or the torque) needed to overcome the ER is nearly constant along the movement (3), but at the beginning of the movement it is lower as compared to CR. This might explain the higher RMS values found during CR. **REFERENCES** 1. Page P, Labbe A, Topp RV. *J Orthop Sports Phys Ther.*(2000);A30:47-48. 2. G. Melchiorri, A. Rainoldi. (2011) *Journal of Electromyography and Kinesiology*; 21.6: 954-959. 3. Page, P., Labbe, A., Topp, R. V. (2000). *J Orthop Sports Phys Ther*; 30(1), 47-8. **CONTACT** (sartoriogabriela@gmail.com)

### A NEW COMBINED APPROACH OF FATIGUE ANALYSIS DURING 100 METRES SPRINTS

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**Introduction** A phenomenon known under the term fatigue is an exercise-induced reduction in the maximal force capacity of muscles. Fatigue occurs in central and peripheral locations, and it depends on the intensity and time.[1] Compounding different measuring methods (3x3-D accelerometer and gyroscope, Tensiomyography), we would like to identify most significant fatigue related parameters, during the last 30-meter phase of 100meter sprints. **Methods** Twenty national level sprinters participated in the study. They ran three times 100m with 10 minute break in between. Sprinter motions were captured with data logger at 1 KS/s in the lower lumbar area and on each foot instep. Accelerometer (±24 G) and gyroscope signals from Sensmotion loggers (TMG Ljubljana) were filtered with a Butterworth

lowpass filter (cutoff: 150 Hz, order: 5). Sprinting track was divided into two nearly steady states, the first state from 40m to 70m and the second from 70m to 100m, within which running velocity and stride rate were monitored. We used TMG system to measure biceps femoris (BF) contractile properties before first and after each sprint in 30-second increments for 1 minute. A Fast Fourier Transform (FFT) was used as an estimator of a stride rate for data logger signals. We used a new approach called maximal rate of force development in time (mRFDt). mRFDt algorithm determines the changes of TMG displacement (Dm) over time within 5 ms time window.[2] To determine statistically significant differences we used a Student T-test. Results All three sprints contain a statistically significant drop in stride rate in second section of approximately 2 %, in the first sprint from 4.35 to 4.25, in the second sprint from 4.33 to 4.24 and in the third sprint from 4.29 to 4.22. Results showed a significant statistical difference ( $p < 0.01$ ) between the first and the second section. Results of mRFDt algorithm showed a statistically significant drop in BF muscle twitch force development abilities. The mRFDt analysis in the first sprint statistically significantly decreases from 0.73 to 0.61 mms<sup>-3</sup> ( $p < 0.01$ ), in the second sprint from 0.72 to 0.58 mms<sup>-3</sup> ( $p < 0.01$ ), and in the third sprint from 0.62 to 0.52 mms<sup>-3</sup> ( $p < 0.01$ ). Discussion Testing protocol is an overall known method of developing specific velocity endurance. Many studies showed that athletes lower stride rate and extended stride length under the influence of fatigue in the last 20m of the sprint[1]. mRFDt shows a drop of contractile speed (decrease of mRFDt) of BF muscle, which is one of the most important muscles for a maximal velocity development in sprint. The decline of stride rate and a drop in contractile speed of the muscle indicate the presence of fatigue. Decrease in mRFDt of BF inside each set from the first to third measurement was also observed. Further studies are necessary to understand the mechanism of twitch contractile speed decrease during first 70 seconds of resting period. References 1. Ross A, et al. Sports Med. 2001;31(6):409–25. 2. Aagaard Pet all. J Appl Physiol. 2002;93(4):1318–26.

## Mini-Orals

### MO-SH03 Physical Education and Pedagogics II

#### ASSESSMENT IN PHYSICAL EDUCATION

Sebelius, S.

*Faculty of Education, Malmö University*

ASSESSMENT IN PHYSICAL EDUCATION Introduction For some years, there has been discussions in Sweden about assessment in physical education and the problems surrounding it; teachers are not assessing according to the governing standards (Quennerstedt, Öhman & Eriksson, 2008) and students have little knowledge about the basis of the assessment (Redelius & Hay, 2012). These aspects are crucial for assessment efficacy in physical education (Hay & Penney, 2009). The aim of the project is to investigate and problematize teachers statements about how they mediate to the students the basis of the assessment and how they assess students, with focus on "...the ability to move comprehensively in different physical contexts"(Skolverket, 2011, p. 51). Methods The empirical sample of this qualitative study consists of three parts: individual interviews with three teachers who teach physical education, questionnaires from their students in three classes in grade nine (74 students) and observations of the teachers lessons in physical education with the same classes in grade nine (13 lessons). Results The teachers state that they inform the students about upcoming assessments, both orally and in writing, a couple of times each semester. The students are unsure about how the basis of the assessment is being mediated to them. The teachers also state that they assess the students every lesson. During the lessons, the assessments visible to the students primarily consist of interjections like 'well done' and feedback on techniques. The students are unsure about when they are being assessed and on what basis they are being assessed. Discussion There is a conflict between what the teachers and the students state concerning when the students are being assessed and how they are being informed about the basis of it. The teachers say that they assess the students every lesson but the students are unsure about when they are being assessed. Why is there an inconsistency between the teachers and the students' statements and why are the teachers assessing the students every lesson? References Hay & Penney (2009) Proposing conditions for assessment efficacy in physical education. *European Physical Education Review*, 15:3, 389-405. Skolverket (2011) *Läroplan för grundskolan, förskoleklassen och fritidshemmet 2011*. Stockholm: Statens skolverk, Fritzes offentliga publikationer Quennerstedt, Öhman & Eriksson (2008) Physical education in Sweden – a national evaluation. *Education – line*, s. 1-17. Redelius & Hay (2012) Student views on criterion-referenced assessment and grading in Swedish physical education. *Physical Education and Sport Pedagogy*, 17:2, 211-225 Contact sofia.sebelius@mah.se

#### FOCUS GROUPS DISCUSSION ABOUT ASSESSMENT IN PHYSICAL EDUCATION AND HEALTH

Bexell, S.

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Introduction Many studies in Physical Education and Health have shown a lack of equivalence, transparency and validity in assessment and grading. At the same time, there is a great expectation that teachers can make fair and equal assessments. National Agency for Education (2011) has set up a perspective for a fair and equitable assessment and grading, and writes that the curriculum for primary schools (Läroplan för grundskolan 2011) are clearer and provides greater clarification of requirements for assessment. According to National Agency for Education (2011) teachers have thereby more opportunities to make similar assessment. The study is a project with a group of teachers at local level, working for a common interpretation of assessment issues according to curriculum for primary schools 2011. The teachers who participated in the project did so voluntarily and most of them have long experience of being a teacher in physical education and health. The purpose of the study is to examine the process where teachers in PEH are working for a common understanding of assessment issues based on the curriculum for primary schools and thereby problematise the process and make it visible. Method The project design is based on action research principles of planning, acting, observing and reflecting. It consist of three cycles. In cycle one educational assessment – support (Skolverket, 2012) is used as a basis for group discussions, in cycle two teachers own video filming are used and in the third cycle the teachers made a number of there own actions in different areas of work with a model that was based on research and group insights during the project. The empirical results consist essentially from focus group discussions on all the different cycles. Results The process and the focus group have been analyzed critically from a social constructionist perspective to the concept of dramaturgy as a theoretical lens (Goffman, 2009). The results show that the beliefs teachers bring into the project are difficult to change. Instead the teachers look on the process and social interaction support for what they consider to be important in both teaching and how knowledge is interpreted. The individual teachers' background, history and personal experiences have a major impact on how they interpret and perceive assessment and grading. There are indications in the results that it seems to be easier to absorb a

change in the assessment process rather than to agree on how the proficiency key values are interpreted. The teachers' statement after the project also shows that they have benefited from the project in their work with assessment issues. stefan.bexell@mah.se

## BACKGROUND AND SIGNIFICANCE OF ADOPTING RHYTHMIC DANCE AS CURRICULUM OF PE IN JAPAN

Park, K., Murata, Y.

*University of Tsukuba*

**Introduction** In Japan, rhythmic dance (RD) such as rock'n'roll and hip-hop has been adopted as a part of dance curriculum of PE. Therefore, this study aims to examine background and educational significance with which RD was adopted as curriculum of PE in Japan. **Methods** This study reviewed Japan's Course of Study, its manual and related teaching materials. Results RD was born with the rhythm and movement of popular music that was in fashion at a certain time combined each other and is at the center of dance boom of the present age. Socially, this dance is easily accessed with great interest by students with plenty of opportunities to be exposed to dance through diverse media and with music played in their daily lives all the time. Against this backdrop, RD was newly adopted in Japan's Course of Study of 1998. In the Course of Study, RD is defined as a dance to modern rhythm and exciting free-style dance of thinking about how to get into rhythm, how to move one's body and how to react to others. As for rhythms covered by RD, samba, rock'n'roll and hip-hop are suggested. Examining the significance of adopting RD as curriculum from the viewpoint of teaching, first of all, RD puts emphasis on dancing to a rhythm by whole body. In particular, it focuses on expressing the characteristics of each rhythm with entire body such as bound of body and after-beat of rock'n'roll, syncopation of samba and up/down beat of hip-hop. Getting into rhythm means dancing with body and music becoming one as if even a hair is dancing. A joy of dancing to a rhythm comes from pleasure of being intoxicated by rhythm and pleasure of dance routine that human beings have by nature, which is related with what makes people realize that they are naturally beings of dancing. Second, RD makes much of dancing freely by getting into rhythm spontaneously rather than dancing by memorizing certain choreography. Based on this, students can make original pattern of rhythm or continuation of movement and select the music they are fond of to create their original dance, which can lead to activities that they can observe together and exchange. This leads to the third point of teaching, which is dancing with friends. This enables students to feel the joy of dancing in reaction to the other party through activities such as lead and imitating movement. **Discussion** As such, RD was introduced in Japan as a result of carefully selecting content of teaching to have clear educational significance and realize the significance instead of simply dancing to the music of popular singers by memorizing dance routine. This also seems to reflect an intention of flexibly responding to music and dance of changing times. The Japan's case can be a good example of reflecting the requirement of society and students and valuing the meaning of school education. **References** Park, K. (2013) Comparison of the dance-related contents in the physical education of Japanese and Korean national curricula. Doctoral dissertation of University of Tsukuba, Japan Contact parkkj@taiiku.tsukuba.ac.jp

## ACTION RESEARCH IN EXPLORING HOW PE TEACHERS ORIENTATE THEIR "VALUE OF PHYSICAL EDUCATION" IN SCHOOLS

Sum, K.

*The Chinese University of Hong Kong*

This action research explored how physical education teachers can orientate their values of physical education in the Hong Kong secondary and primary schools where they teach. One primary school PE teacher and one secondary school PE teacher participated in this study. With the help of research tools including the Teaching Perspective Inventory(TPI) (Collins & Pratt, 2011) and the Value Orientation Inventory (VOI) (Ennis & Chen, 1993), they underwent two cycles of intervention assisted by the researchers which offered group-reflection, extensive sharing of experience and academic findings. The researchers intentionally consisted of physical education teachers from different settings and offered opportunities to expand the scope of and reflect on their 'value of physical education'. In each cycle, they planned and implemented one physical education lesson focusing the specific rationale behind, engaged in self-reflection and group reflection after the lesson, and developed corresponding strategies for the next cycle of teaching. All the lessons and reflection meetings were video-taped. Through the process, the two participants were able to realise how their teaching styles may have been personalised according to their intentions and beliefs. This in turn allowed the researchers to appreciate how cultural and social variations of teaching physical education is understood and valued. In conclusion, a model was proposed to conceptualize how physical education teachers can orientate their value of physical education in the schools they teach. Further, the reflection process in group consisting of teachers of physical education from different settings allowed the participants to clarify their self-understanding on teaching perspectives and reinforce their values towards physical education.

## THE PUPILS' UNDERSTANDING FOR AND ATTITUDE TOWARDS THEIR OWN HEALTH

Ahlberg, A.

*Malmö University*

**Introduction** The concept of health should not be viewed as one-dimensional, but rather a complex interplay between physical, psychological and social factors (World Health Organization, 2014). This is important because it is more reflective of the 'messy' nature of pupil's lived experiences. Further to this, the Swedish curriculum highlights that the school's responsibilities is to support pupil's knowledge and promote health, through developing pupil's habits in a positive way, as well as connecting concepts surrounding physical activity with mental and physical well being. The purpose of this study, therefore, was to consider the pupil's understanding for and attitudes towards their own health. This was explored through the following questions: 1) What is health for pupils? 2) What do the pupils think is relevant to learn about health in the school subject Physical education and health? 3) What opportunities and challenges do pupils experience around health in everyday life? **Methods** Data was collected through the use of focus groups, questionnaires, epistolary dialog and conclusive questionnaires. The pupils' way of describing health was analysed through Zygmunt Bauman's (2008) consuming theory and Thomas Ziehe's (1986, 1999) conceptions cultural liberation, cultural expropriation, performance principle and authenticity. **Results and Discussion** The result shows that the pupils in the study had a good level of knowledge about health. They described health as a complex concept in physical, psychological and social terms. This knowledge affected the pupils in different ways. For example a feeling of pleasure for those pupils who appear well grounded and spontaneous. While among the pupils who experience pressure in their daily life, the contribution of their knowledge instead placed a feeling of higher demands. **Conclusion** When it comes to health and education about health, it is not primarily a varied level of knowledge the teacher needs to take into account, but the variation in students' self-images. It is not theory of health that primary should support the teacher, it is theory about young people and their lives. If the school helps students to

develop a positive self-image, then they are susceptible and can learn to manage their health in a good way. References Bauman, Zygmunt (2008). Konsumtionsliv. Goteborg: Daidalos. Ziehe, Thomas (1986). Ny ungdom. Om ovanliga larprocesser. Malmo: Nordstedts. Ziehe, Thomas (1999). God anderledeshed. Retrieved 28th of September 2014 from: <http://tekster.wikispaces.com/file/view/Ziehe%2C+Thomas+%281999%29+-+God+Anderledeshed.pdf> World Health Organization (2014). Retrieved 19th of December 2014 from: [http://www.who.int/features/factfiles/mental\\_health/en/](http://www.who.int/features/factfiles/mental_health/en/) Contact annika.ahlberg@mah.se

## 15:00 - 16:30

### Invited symposia

#### IS-PM02 THE BENGT SALTIN TRIBUTE SYMPOSIUM

##### PROFESSOR BENGT SALTIN'S LEGACY AND CONTRIBUTION TO THE ECSS

Narici, M.V.

*University of Nottingham*

In 1995, the Faculty of Sport Science of the University of Nice Sophia Antipolis, hosted the 5th International Symposium on Exercise and Sports Biology, as part of a series of quadrennial congresses organized by Professor Pierre Marconnet. The symposium ended with an event of major importance: the foundation of the European College of Sport Science (ECSS) by a group of fourteen leading exercise and sport scientists. Amongst these was Professor Bengt Saltin, appointed as first ECSS President. The College held its first congress in 1996 in Nice, in cooperation with the Faculty of Sport Science of the University of Nice. The founding members of the ECSS could not have made a better decision in electing Bengt Saltin as College President, for he had the quintessential nature of a true exercise scientist backed by extremely solid foundations in human and applied physiology. When elected in 1996, Prof Saltin was author of more than 250 papers and was already ranking as one of the most acclaimed international leaders in Muscle and Environmental Physiology of the 20th Century. Professor Saltin brought to the ECSS his deep knowledge, his rigor in empirical research, his passion for integrative physiology through a mechanistic approach and a remarkable ability to act as catalyst for research initiatives and scientific debate. His knowledge and expertise in human physiology had tremendous breadth: these covered, i) cardio-vascular and cardio-respiratory physiology, ii) aerobic and anaerobic metabolism, iii) muscle energetics and muscle fatigue, iv) muscle fibre composition, metabolic and functional properties, v) exercise endocrinology, vi) glucose metabolism and obesity, vii) exercise nutrition, viii) neuromuscular performance in health and disease, ix) impact of ageing on aerobic and anaerobic metabolism and muscle performance, x) altitude physiology, xi) space physiology, xii) thermoregulation during exercise, xiii) cellular and molecular mechanisms of muscle performance in health, disease and in different environmental conditions, xiv) doping detection and prevention in sports. Undoubtedly, Bengt Saltin was a true pioneer in exercise physiology, the depth and innovative nature of his work always placed him at the forefront of integrative physiology research. His seminal work inspired and guided thousands of research scientists and students and made a major contribution to the development of the ECSS as a society dedicated to excellence in sport science and research at the European level. As current President of the ECSS, I feel honoured and humbled by Professor Saltin's contribution, his spirit and legacy will always be the motor of our College. Acknowledgement: my sincere gratitude to Professor Pierre Marconnet for his invaluable help in reconstructing the early history of the ECSS.

##### INTEGRATIVE PHYSIOLOGICAL APPROACHES FOR OPTIMIZING MUSCULAR PERFORMANCE AND HEALTH

Sjogaard, G.

*University of Southern Denmark*

Bengt Saltin was appointed professor at the at the University of Copenhagen's August Krogh Institute in 1972 after formative years in Stockholm at the Department of Physiology, Karolinska Institutet at GIH. He remained closely connected to these institutes throughout his life. His research from start evidenced basic physiological mechanisms (Bergström et al 1967) and at the same time launched methods to address applied health related issues (Saltin and Grimby 1968). Human muscle physiology was his special focus and he succeeded to invent a human in situ muscle model that allowed revealing integrative cardiovascular mechanism as well as reductionist subcellular structures and electrolyte distributions (Sjogaard and Saltin 1982, Andersen et al 1985). Applied studies on sports performances ranged from running, skiing, cycling to camel racing, increasing our understanding of fatigue mechanisms and adequate training regimes. Studies were undertaken under extreme conditions such as heat stress or high altitude (Nielsen et al 1990, Savard et al 1995). He was eminent in applying novel analytical tools and techniques but always turned research questions back into integrative in vivo human conditions. Physical activity and health had his highest interest and he spent much energy to evidence guidelines for health promotion (Pedersen and Saltin 2006). In some of his latest publications he addressed the working population among whom sedentary behavior and musculoskeletal disorders are frequent. Repetitive stressful work was shown to decrease mRNA levels of key regulators for growth and oxidative metabolism in the painful muscles while in contrast strengthening exercises performed at the worksite for health promotion improved the capacity of carbohydrate oxidation and muscle performance (Sjogaard et al 2013, Gerdle et al 2014, Andersen et al 2014). Bengt Saltin's scientific contributions are extreme in breadth and depth; specifying some is not to ignore all the others - many of which will be presented by many of his numerous collaborators at this conference. References Andersen LL, Andersen CH, Skotte JH, Suetta C, Søgaard K, Saltin B, Sjogaard G, Biomed Res Int 187324 (2014) Andersen P, Adams RP, Sjogaard G, Thorboe A, Saltin B, J Appl Physiol 59, 1647 (1985) Bergström J, Hermansen L, Hultman E, Saltin B, Acta Physiol Scand 71, 140 (1967) Gerdle B, Kristiansen J, Larsson B, Saltin B, Søgaard K, Sjogaard G, BMC Musculoskel Disord 15, 357 (2014) Nielsen B, Savard G, Richter EA, Hargreaves M, Saltin B, J Appl Physiol 69, 1040 (1990) Pedersen BK, Saltin B, Scand J Med Sci Sports 16 Suppl 1, 3 (2006) Saltin B, Grimby G, Circulation 38, 1104 (1968) Savard GK, Areskog NH, Saltin B, Acta Physiol Scand 154, 499 (1995) Sjogaard G, Saltin B, Am J Physiol 243, R271 (1982) Sjogaard G, Zebis MK, Kiilrich K, Saltin B, Pilegaard H, Biomed Res Int 984523 (2013) Contact gsjogaard@health.sdu.dk

**ROLE OF MUSCLE GLYCOGEN IN EXERCISE METABOLISM AND PERFORMANCE**

Graham, T.

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Early in his career, Saltin and coworkers (Bergstrom et al 1967, Hermansen et al, 1967) investigated the metabolism of human muscle glycogen during exercise and recovery as well as responses within fibre type and even single fibres (Gollnick et al 1974). Today glycogen super compensation, exponential catabolism of glycogen with exercise duration, the association between fatigue and glycogen, and the fibre type-specific differences could be viewed as simplistic and not insightful. However, in the 1970's the findings were remarkable, represented the first invasive investigations of metabolism of human muscle, the body of work integrated our physiological understanding and, in hindsight, the data were remarkably precise. This work presented questions such as why is there an upper limit to glycogen stores, how does glycogen limit exercise capacity and how is the breakdown and resynthesis of glycogen regulated? In the next 20-25 years advancement in our understanding of glycogen metabolism advanced slowly and most studies were descriptive, providing limited further insight. However, in the last 20 years, scientists (some collaborating with Saltin : Graham et al, 2001, Nielsen et al, 2011, Ørtenblad et al ,2011) began to address important questions using advances in molecular biology as well as computer technology for microscopic image analysis (Marchand et al, 2007). We now realize that the glycogen granules have specific subcellular locations that reflect function. The granules have a very complex structure, are associated with a family of proteins and at least some of which are capable of dynamic subcellular translocation. These findings demonstrate that metabolic regulation of glycogen occurs within subcellular pools specific to location and that key proteins can quickly move from one location to another (Graham, 2009, J Nielsen and N Ørtenblad, 2013) , . Scientists are now positioned such that they can and should follow Saltin's example designing the protocols to address the important issues, including those questions generated over 40 years ago. References Bergstrom, J., Hermansen, L., Hultman, E., and Saltin, B. *Acta Physiol. Scand.* 71: 140, (1967). Hermansen, L., Hultman, E., and Saltin, B. *Acta Physiol. Scand.* 71: 129, (1967). Gollnick, P.D., Piehl, K., and Saltin, B.. *J. Physiol.* 241: 45 (1974). Graham, T.E., K.B. Adamo, J. Shearer, I. Marchand, and B. Saltin. *J Appl Physiol* 90:873 (2001). Marchand, I, M Tarnopolsky, K B Adamo, J M Bourgeois, K Chorneyko, and T E Graham. *J Physiol* 580: 617 (2007). Graham, TE. *Appl Physiol Nutr Metabol.* 34: 488 (2009). Nielsen J and N Ørtenblad. *Appl Physiol Nutr and Metab* 38: 91,(2013). Nielsen, J., Holmberg, H.C., Schrøder, H.D., Saltin, B., and Ørtenblad, N. *J Physiol* 589: 2871 (2011) Ørtenblad, N., Nielsen, J., Saltin, B., and Holmberg, H.C. *J. Physiol.* 589:711, (2011) Contact: terrygra@uoguelph.ca Do not insert authors here

**EXERCISE TRAINING-INDUCED REGULATION OF MITOCHONDRIAL BIOGENESIS AND MITOPHAGY**

Pilegaard, H.

*University of Copenhagen*

Bengt Saltin performed together with his colleagues in 1966 the Dallas bed rest study, which became a classical study within human physiology (Saltin et al 1968). The study demonstrated pronounced effects of only 3 weeks of physical inactivity on cardiovascular function. Over the years he was also involved in numerous studies examining skeletal muscle metabolism with emphasis on exercise training adaptations. At the end of the 1990's and the years that followed, Bengt Saltin contributed to taking a step further into the understanding of the molecular mechanisms behind exercise training-induced adaptations in skeletal muscle metabolism. The studies showed that a single exercise bout induces transient transcriptional activation of a broad range of genes encoding proteins in metabolism and transcriptional regulators in skeletal muscle (Pilegaard et al. 2000; Pilegaard et al. 2003). Further studies examined the potential role of muscle glycogen and plasma free fatty acids in the regulation of exercise-induced mRNA responses in human skeletal muscle. Bengt Saltin was also a major player in a bed rest study conducted in Copenhagen with the main purpose to investigate the underlying mechanisms behind physical inactivity-induced insulin resistance and the impact of physical inactivity on exercise-induced mRNA responses in human skeletal muscle (Ringholm et al 2011). Furthermore, he took part in studying the impact of age and lifelong exercise training on mitochondrial oxidative capacity and exercise-induced mRNA responses in human skeletal muscle (Iversen et al 2011). Over the last 10 years, we have examined the impact of the transcriptional co-activator PGC-1 $\alpha$  on basal and exercise training-induced regulation of metabolic proteins in skeletal muscle at young and old age (Leick et al 2008; Ringholm et al 2013). Current studies focus on the potential role of PGC-1 $\alpha$  in exercise and exercise training-induced regulation of mitochondrial quality control in skeletal muscle. References Saltin B, Blomqvist G, Mitchell JH, Johnson RL, Wildenthal K, Chapman CB.: *Circulation*; 37 and 38 (5 Suppl): VIII-78, 1968. Pilegaard, H, GA Ordway, B Saltin, PD Neuffer. *Am. J. Physiol.* 279: E806-E14, 2000. Pilegaard, H, B Saltin, and PD Neuffer. *J Physiol* 546: 851-58, 2003. Ringholm S, Biensø RS, Kiilerich K, Guadalupe-Grau A, Aachmann-Andersen NJ, Saltin B, Plomgaard P, Lundby C, Wojtaszewski JF, Calbet JA, Pilegaard H. *Am J Physiol* 301(4): E649-E58, 2011. Iversen N, Krstrup P, Rasmussen HN, Rasmussen UF, Saltin B, Pilegaard H. *Exp Gerontol* 46: 670-78, 2011. Leick L, Wojtaszewski JFP, Johansen ST, Kiilerich K, Comes G, Hellsten Y, Hidalgo J, Pilegaard H. *Am J Physiol Endocrinol Metab* 294: E463-74, 2008. Ringholm S, Olesen J, Pedersen JT, Brandt CT, Halling JF, Hellsten Y, Prats C, Pilegaard H. *Exp Gerontol* 48: 1311-18, 2013. Contact hpilegaard@bio.ku.dk

**THE ESSENTIAL OF INTERDISCIPLINARY RESPECT IN RESEARCH FOR A SUSTAINABLE UNDERSTANDING OF HUMAN PHYSICAL ACTIVITY AND SPORT**

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Physical exercise is essential for the human body and diets should be adapted to how many calories, minerals, vitamins, proteins, carbohydrates etcetera that the body is in need of. This is known worldwide, it seems, however, extremely difficult for most of us to live according to this knowledge. Many people all over the world are not physically active as much as they ought to and many of us eat more or less than we are supposed to. Why? This question and many others related to an interdisciplinary understanding of the human body, PA and diets signified our work together with Bengt Saltin in the project World Village of Women Sport. Bengt was involved in many sports related projects all over the world and it was possibly this that made him aware of the importance of understanding the social and cultural context of sport and sportsmen and women. Problems of doping pointed to the importance of understanding a wide sport context and questions regarding obesity taught him that in some parts of the world obesity is seen only in the upper class, whereas in other parts obesity is connected to the working class. Even though the physiological status may be the same – the programs for solving problems related to doping or obesity have to be designed in many different ways to actually reach the goals. Since 2008 Bengt Saltin was deeply involved in developing the project World Village of women sports in his role as chair of the World Village of Women Sports (VWWS) Scientific Board. The purpose of World Village of Women Sports (VWWS) was to significantly advance the position of women's sports through



new knowledge generated within an international research and development centre in Malmö. A starting point for the project was that women and men, girls and boys should have the same opportunities, rights and obligations within sport and that this is not the case. Women and girls do not have the same opportunities to participate in sport, nor have they had such opportunities historically. Neither have they had access to the same resources within sport as men and boys. Saltin acknowledged that this also applies to sports research and not the least interdisciplinary research was discussed within the project. How can women's knee injuries in football be understood from an interdisciplinary perspective – what can our knowledge on women's physiology teach us? What about biomechanical knowledge? And from our perspective, the humanities and social sciences, questions regarding whether the lack of economic resources can be connected to knee injuries can be posed. Let us work in the spirit of Bengt Saltin for a sustainable solution to problems related to physical activity and sport!

## Invited symposia

### IS-PM10 THE ATHLETE'S BIOLOGICAL PASSPORT – WHAT'S THE STATUS? \*

#### THE ATHLETES BIOLOGICAL PASSPORT - WHAT'S THE STATUS

Morkeberg, J.

*Uni Copenhagen*

The Hematological Module of the Athlete Biological Passport (ABP) was approved by the World Anti-Doping Agency (WADA) in 2009 with the objective of indirectly detecting doping substances or methods used to increase the body's oxygen carrying capacity such as erythropoiesis stimulating agents (ESAs) or autologous blood transfusions. Biomarkers affiliated to the hematopoietic system are monitored on the individual level over time and atypical fluctuations are evaluated by an expert panel. ABP results are either used to sanction athletes or target additional tests or analyses. An evaluation of hematological data obtained from professional cyclist showed a marked decrease in abnormal hematological values after the introduction of the ABP by the Union Cyclist Internationale (UCI). In addition there has been a decrease in the number of ABP cases since the introduction of the passport. This could either indicate a decreased abuse of blood manipulation or a shift towards other substances of changed manipulation practices. The sensitivity of the blood passport could be increased by the introduction of plasma volume independent biomarkers, while the use of an alternative EPO detection method (MAIA test) and different 'omics' approaches have shown potential as well.

#### THE STEROIDAL MODULE

Schulze, J.

*Nordic Athlete Passport Management Unit*

Detection of doping with endogenous steroids, such as testosterone, has been and continues to be a challenge. To overcome the problem of separating testosterone doping from endogenous testosterone the urinary ratio between the glucuronides of testosterone and epitestosterone (T/E) is used. This T/E ratio was introduced in doping tests with an authorized upper limit of 4. Interestingly, the mean T/E ratio in Caucasian men is approximately 1, whereas in Asians, the mean ratio is considerably lower. The ethnic disparity in the T/E ratio was shown to be strongly associated with a deletion polymorphism in the gene for testosterone glucuronidation (UGT2B17). Individuals homozygous for this deletion (del/del) rarely reach a T/E ratio of 4 when doped with testosterone. The deletion polymorphism is much more common in East Asian populations (70-85 %) as compared to Caucasians and Africans (around 10-20 %). There are also individuals that have naturally high T/E ratios due to decreased excretion of epitestosterone, partly also explained by a genetic polymorphism. In addition to genetic variation, other factors, such as hormonal contraceptives, have been shown to impact the steroid profile. The steroid module of the Athlete Biological Passport, the newest innovation in doping testing, was finalized and implemented in January 2014. Instead of the population based cut off ratio, every athlete now has their own individual cut-off limit of the T/E ratio. In addition to the T/E ratio, other ratios of testosterone metabolites are used as markers, e.g. the androsterone/etiocholanolone and the 5 alpha and 5 beta androstenediol ratios. Using the steroidal module of the passport the sensitivity of the doping test has considerably improved and the need for expensive and time-consuming confirmation analyses has decreased.

#### THE ENDOCRINE MODULE

Dehnes, Y.

*Oslo University Hospital*

Testing for growth hormone (GH) has been a major issue for most anti-doping organizations for several years. The GH-isoform differential assays have been in use since 2008 and are currently used by all the WADA (World Anti-Doping Agency) accredited laboratories, however, direct detection of GH-misuse is complicated because it is an endogenously produced hormone and because its half-life is very short. An indirect detection method for rhGH misuse using GH-dependent markers was under development for well over a decade. Measurement of the GH biomarkers insulin-like growth factor-1 (IGF-1) and N-terminal peptide of type III procollagen (PIIINP) in combination with discriminant function analysis was found to differentiate between doped and not doped. This test was validated - using population-based thresholds - prior to the Olympic Games in London 2012. In the fall of 2008, Norwegian Doping Control Laboratory, Anti-doping Norway and the Norwegian School of Sports Science started up a research project aimed at establishing individual GH biomarker profiles and to determine within-subject variability. The rationale behind this was an assumption that GH testing would benefit greatly from combining the direct method (the isoform approach) with longitudinal profiles of the indirect method (GH biomarkers IGF-1 and PIIINP). A critical parameter for increased sensitivity with longitudinal profiles is significantly lower within-subject than between-subject variability. To determine this, a group of national level athletes were followed over a period of 2 years. Further, we wanted to see how GH-doping would alter the longitudinal biomarker profiles, but a long-term GH-application study would never be approved by Norwegian ethical committees. We therefore recruited bodybuilders who had a private consume of GH to an uncontrolled study. Promising results from this study motivated Anti-Doping Norway to start monitoring athletes from their national and registered testing pools in the beginning of 2011. The results from both the research project and the monitoring of Norwegian elite athletes - with GH-marker profiles up to 4 years long - will be presented.

## Invited symposia

### **IS-PM06 SKELETAL MUSCLE ADAPTATIONS TO ENDURANCE TRAINING: IS TISSUE HYPOXIA THE MAIN SIGNAL?**

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#### **CARDIAC AND SKELETAL MUSCLE METABOLISM IN HIGH ALTITUDE HYPOXIA**

Murray, A.J.

*University of Cambridge*

In most tissues of the body, cellular ATP production predominantly occurs via mitochondrial oxidative phosphorylation of reduced intermediates, which are in turn derived from substrates such as glucose and fatty acids. In order to maintain ATP homeostasis, and therefore cellular function, the mitochondria require a constant supply of fuels and oxygen. In many disease states, or in healthy individuals at altitude, tissue oxygen levels fall and the cell must meet this hypoxic challenge to maintain energetics and limit oxidative stress. For oxidative tissues such as heart or skeletal muscle, cellular hypoxia necessitates changes in gene and protein expression that alter mitochondrial function. It is known that lowlanders returning from high altitude have decreased muscle mitochondrial densities, yet the underlying transcriptional mechanisms and time course were not fully understood. To explore these, we measured gene and protein expression plus ultrastructure in muscle biopsies of lowlanders at sea level and following exposure to hypobaric hypoxia. Subacute exposure (19 d after initiating ascent to Everest base camp, 5300 m) was not associated with mitochondrial loss. After 66 d at altitude and ascent beyond 6400 m, mitochondrial densities fell by 21%, with loss of 73% of subsarcolemmal mitochondria. Correspondingly, levels of the transcriptional coactivator PGC-1 $\alpha$  fell by 35%, suggesting down-regulation of mitochondrial biogenesis. Sustained hypoxia also decreased expression of electron transport chain complexes I and IV and UCP3 levels. We suggest that during subacute hypoxia, mitochondria might be protected from oxidative stress. However, following sustained exposure, mitochondrial biogenesis is deactivated and uncoupling down-regulated, perhaps to improve the efficiency of ATP production.

#### **SKELETAL MUSCLE HIF-1 AND EXERCISE**

Rundqvist, H.

*Karolinska Institutet*

**Introduction** Skeletal muscle tissue exhibits a remarkable ability to adjust to altered demands. Training adaptations include increased capillarisation, altered glycolytic flux and increased mitochondrial density and occur in response to repeated bouts of exercise. Exercise induced skeletal muscle hypoxia has been addressed as one possible primary stimulus for adaptation to training. Hypoxia Inducible Factor-1 (HIF-1) is an evolutionary conserved master regulator of hypoxic transcription and suggested as a candidate for mediating hypoxia induced training adaptation. **Methods** Skeletal muscle biopsies were obtained from m. vastus lateralis in three human experimental set ups; a single bout of exercise, six weeks of endurance training and elite athletes. In addition, a skeletal muscle specific HIF-1 $\alpha$  KO mouse model exposed to six weeks of endurance training was used to further evaluate the role of HIF-1 in skeletal muscle adaptation. **Results** Results showed that acute exercise activated HIF-1, including protein stabilization, translocation to the nucleus, and increased target gene expression in both human and mouse skeletal muscle. However, the HIF-1 $\alpha$  KO mice showed several of the features typically associated with a trained muscle, especially in respect of mitochondrial characteristics, mediated partly through decreased levels of pyruvate dehydrogenase kinase 1 (PDK-1). In elite athletes, expression of several negative regulators of HIF-1 was significantly higher than in moderately active individuals, while the response gene PDK-1 was lower. Similar results were observed in the six-week training study. **Discussion** We suggest that an initial activation of HIF-1 may drive angiogenesis adaptation in the early phase of training, but the seeming attenuation of the HIF-1 response later in a training period and in elite athletes may represent a switch toward a higher capacity to activate the oxidative system.

#### **TISSUE HYPOXIA AND THE HUMAN SKELETAL MUSCLE**

Lundby, C.

*University of Zürich*

Mitochondrial volume density MitoVD is increased with endurance training. In this presentation the following will be discussed i) Whether tissue hypoxia is involved or not has been difficult to answer since on one hand humans exposed to high altitude hypoxia for several weeks in the Himalayas demonstrate a decrease in MitoVD whereas exercise training studies in which hypoxia has been added to the training (Live Low – Train High) approach has revealed an superimposing effect of hypoxia on the training induced increase in MitoVD. This discrepancy will be discussed and favor hypoxia to stimulate mitochondrial biogenesis ii) Assuming that mitochondrial oxidative capacity (OXPHOS) exceeds systemic O<sub>2</sub> transport then what is the consequence for an improved MitoVD with exercise training? Recent findings suggest that the improvements are of no relevance for VO<sub>2</sub>max type of exercise and this will be discussed.

## Oral presentations

### **OP-PM02 Health, Training & Performance**

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#### **THE INFLUENCE OF ANTHROPOMETRIC AND MATURATIONAL CHARACTERISTICS ON THE RELATIVE AGE EFFECT IN ALPINE SKI RACING**

Müller, L.1, Hildebrandt, C.1, Müller, E.2, Raschner, C.1

*1 University of Innsbruck, 2 University of Salzburg*

**Introduction** A relative age effect (RAE), which consists of an over-representation of athletes born early in a selection year, was shown to be present in all age categories of national and international alpine ski racing (Müller et al., 2015). Before strategies in the talent devel-

opment systems can be changed to minimize the RAE, it is necessary to find the most important causal mechanisms of it. Methods The study included the investigation of 695 Austrian pupils (10-13 years): 234 (131 males, 103 females) provincial youth ski racers of skiing specific schools (P-SR), 84 (42 m, 42 f) youth ski racers of national final races (N-SR) and 413 (173 m, 240 f) pupils of a secondary modern school (comparison group of non-athletes, CG). Anthropometric measurements were performed, the age at peak height velocity (APHV) (Mirwald et al., 2002) was calculated and the birth months (divided into 4 quarters) were examined. ANOVA or Kruskal Wallis H-Tests assessed differences in anthropometrics and APHV between the pupils born in the single relative age quarters (RAQ). Differences between the 3 groups (P-SR, N-SR, CG) were assessed by t-Tests and Mann-Whitney U Tests. Results A significant RAE was present in the P-SR ( $\chi^2(3, N=234)=8.02$ ;  $p=0.046$ ) and the N-SR ( $\chi^2(3, N=84)=9.00$ ;  $p=0.029$ ). The RAQ-distribution of the CG showed a nearly equal distribution. The P-SR born in RAQ 1 and 2 were taller (Q1: U(76,101)=3721; Q2: U(59,110)=2925.5;  $p<0.001$ ) and heavier (Q1: U(76,101)=3653; Q2: U(59,110)=2827;  $p<0.001$ ) compared to the CG. P-SR born in RAQ 1 were taller ( $\chi^2(3, N=234)=13.06$ ;  $p=0.005$ ) and heavier ( $\chi^2(3, N=234)=9.07$ ;  $p=0.028$ ) compared to P-SR born in RAQ 2-4. P-SR born in one of the four quarters did not significantly differ in APHV from each other and they did not significantly differ in APHV from the CG, neither. The N-SR were significant ( $p<0.001$ ) taller (U(84,413)=15702) and heavier (U(84,413)=15388) compared to the CG and they will reach their individual peak growth spurt at a significant earlier age compared to the P-SR (m: t(171)=2.15,  $p=0.033$ ; f: t(128.7)=4.14,  $p<0.001$ ). Discussion The SR were taller and heavier compared to the CG. The N-SR were advanced in biological maturation compared to the P-SR. The higher the level in youth ski racing, the likelihood for selection of relatively older and more mature athletes increases. Hence, anthropometric and maturational characteristics seem to influence the selection process and seem to be influential mechanisms on the RAE in alpine ski racing. References Müller L, Hildebrandt C, Raschner C. (2015). *J Sports Sci Med*, 14, 16-22. Mirwald RL, Baxter-Jones ADG, Bailey DA, Beunen GP. (2002). *Med Sci Sports Exerc*, 34, 689-694. [Lisa.Mueller@uibk.ac.at]

### THE EFFECTS OF A MULTIFACTORIAL INJURY PREVENTION INTERVENTION ON PHYSICAL EDUCATION TEACHERS' PREVENTIVE BEHAVIOR AND THEIR SPORTS AND WORK RELATED INJURIES

Vercruyse, S., Haerens, L., Verhagen, E., Goossens, L., De Clercq, D.

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Background: Due to the high physical work load (1) and sporting experiences of physical education teachers (PETs), a high injury rate has already been reported among this population (2). Injuries bring along personal and work-related consequences and therefore a multifactorial injury prevention intervention was conducted. The content of the intervention was optimized in 2013 (3) and included the self-determination theory (4) in the way of delivery to enhance teachers' adherence to the proposed strategies. Methods: 104 PETs out of 62 schools in Flanders (Belgium) initially participated in the randomized-controlled trial (RCT). After randomization at school level, and excluding PETs with insufficient registrations, data of 29 PETs in the intervention group (7 men, 22 women;  $47.41 \pm 9.86$  years) and 26 PETs in the control group (15 men, 11 women;  $48.68 \pm 8.50$  years) were analysed. The intervention was delivered to the intervention group exclusively on two separate days, one in September (theoretical + practical) and one in December (practical). Further access was given to the injury prevention website, didactical posters, exercise schedules and regular reminders. Both groups filled out some baseline questions prior to the study and weekly registered preventive behaviour, injuries and time of exposure (being active as teacher, as trainer or practicing sport) during the study. Objective. We wanted to investigate the effect of an intervention on teachers preventive behavior and on the injury prevalence density (total number of sports and work related injuries relatively to 1000h of time of exposure). Results: Intervention group ( $46.6$  min/week) did not significantly differ from the control group ( $36.4$  min/week;  $p=0.254$ ) in the mean time spent in preventive behaviors, but showed a greater variety of strategies (strength, balance, core stability, dynamic and static stretching) being applied, than the controls (warming up). Poisson distribution showed a significant lower injury prevalence density in the intervention group compared to the control group (INT:0.510; CON:1.083;  $p=0.047$ ), with main impact on non-contact injuries (INT=0.185; CON:0.855;  $p=0.007$ ). Discussion and conclusion: Our intervention, first in his kind in PETs, resulted in a more balanced use of the different strategies and significantly reduced injury prevalence density in PETs. Our focus on the intrinsic prevention strategies, might explain the biggest effect on non-contact injuries. References: 1. Sandmark et al (1999). *Appl Ergon*. 30(5): 435-442. 2. Pihl et al. (2002). *J Sports Med Phys Fitness*. 42:466-71. 3. Vercruyse S (2014) *Br J Sports Med*: 48:668. 4. Deci & Ryan (2000). *The Am psychologist*. 55(1): 68-78.

### LEFT AND RIGHT VENTRICULAR AREA-DEFORMATION LOOPS: A NEW NON-INVASIVE TOOL APPLIED TO THE CONCEPT OF EXERCISE-INDUCED CARDIAC FATIGUE

Lord, R., George, K., Somauroo, J., Stenbridge, M., Jain, N., Hoffman, M.D., Shave, R., Haddad, F., Ashley, E., Jones, H., Oxborough, D.

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Introduction Concurrent evaluation of cardiac structure and function can be assessed invasively with pressure-volume loops. We propose a new non-invasive method with simultaneous measurement of ventricular area and tissue deformation that provides temporal mechanical data throughout the same cardiac cycle. We report reliability data for this novel technique and apply this tool to the assessment of exercise-induced cardiac fatigue to develop mechanistic insight. Methods Fifteen participants (body mass  $70.1 \pm 8.8$  kg, height  $179 \pm 6$  cm, age  $40 \pm 8$  years) were recruited to take part in the study. Echocardiograms were performed before, immediately after and 6 hours into recovery from a 100 mile trail race. Standard and speckle-tracking echocardiography assessed right ventricular (RV) and left ventricular (LV) area and longitudinal tissue deformation, respectively. Intra-observer reliability of data was assessed within the physiological range for area and deformation. Following cubic spline interpolation area and deformation were plotted across the same cardiac cycle to construct loops. Results Coefficients of variation for area and tissue deformation ranged from 7 to 21%. The RV area-deformation loop demonstrated a rightward shift post-race with increased RV area ( $26.0$  to  $27.1$  cm<sup>2</sup>,  $P<0.05$ ) and reduced peak RV  $\epsilon$  ( $-28.6$  to  $-25.8\%$ ,  $P<0.05$ ). A leftward shift was observed in the LV longitudinal area-deformation loop post-race secondary to reduced LV area ( $35.8$  to  $32.5$  cm<sup>2</sup>,  $P<0.05$ ) and reduced peak  $\epsilon$  ( $-18.3$  to  $-16.6\%$ ,  $P<0.05$ ). Of interest, the RV area-deformation loop remained displaced at 6 hr recovery, however LV area-deformation values returned towards baseline. Conclusion A new concurrent assessment for cardiac area and deformation has acceptable intra-observer reliability and is sensitive to changes induced in cardiac function by ultra-endurance exercise. Current data suggest dissociation between LV and RV functional changes post-exercise and on-going application of this tool may provide further mechanistic insight into this phenomenon. Contact r.lord@2009.ljmu.ac.uk

**LIFELONG EXERCISE EXPOSURE AND CARDIOVASCULAR RISK: IS THERE AN UPPER LIMIT?**

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*Radboudumc*

**INTRODUCTION** Regular physical activity (PA) reduces cardiovascular morbidity and mortality in the general and athletic population (Chakravarty, Hubert et al. 2008). Recent studies, however, suggest the existence of a J- or U-shaped curve between PA levels and health status, indicating that high doses of PA may abolish the beneficial effects of exercise (Schnohr, O'Keefe et al. 2015). The aim of this study was to assess the relationship between the dose of lifelong physical activity levels and the incidence of cardiovascular risk (CVR) factors (hypertension and hypercholesterolemia) and cardiovascular diseases (CVD) (myocardial infarction, stroke, and heart failure) in an athletic population. **METHODS** Between 2011 - 2014, participants of the 15K Seven Hills Run were invited to complete an online survey regarding their lifelong exercise exposure (time PA per week and exercise intensity) and cardiovascular health. CVR and CVD cases were matched to controls by age and sex. Lifelong exercise exposure (metabolic equivalent of task minutes [METmin]) was calculated from age 18 to the age of CVR/CVD diagnosis. Subjects were categorized into quintiles (Q1 – Q5) based on METmin. Odds ratios (OR) of CVR or CVD were calculated with Q1 as the reference category of exercise. **RESULTS** 1184 participants with CVR (53±7 years old) were matched to 5285 controls and 133 CVD participants (56±7 years) to 4406 controls. The rates of CVR occurrence across quintiles were 19.5%, 18.9%, 18.3%, 17.4%, and 17.5%, respectively. The association between METmin and CVR occurrence (OR [95%-CI]) was for Q2) 1.0 [0.8-1.2], Q3) 0.9 [0.8-1.1], Q4) 0.9 [0.7-1.1], and Q5) 0.9 [0.7-1.1]. Regarding CVD, the rates across quintiles were 3.3%, 2.8%, 2.5%, 2.3%, and 3.8%, respectively. The association between METmin and CVD occurrence (OR [95%-CI]) was for Q2) 0.8 [0.5-1.5], Q3) 0.8 [0.4-1.3], Q4) 0.7 [0.4-1.2], and Q5) 1.2 [0.7-1.9]. **DISCUSSION** The dose of lifelong exercise exposure did not have a significant impact on the occurrence of CVR or CVD. Therefore, our results do not support an upper limit of exercise health benefits. With physical inactivity as one of the most influential risk factors for morbidity worldwide (Lee, Shiroma et al. 2012), we recommend to keep on running. **REFERENCES** Chakravarty EF, Hubert HB, Lingala VB, Fries JF. Reduced disability and mortality among aging runners: a 21-year longitudinal study. *Archives of internal medicine* 2008;168:1638-46. Lee IM, Shiroma EJ, Lobelo F et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet* 2012;380:219-29. Schnohr P, O'Keefe JH, Marott JL, Lange P, Jensen GB. Dose of Jogging and Long-Term Mortality. *Journal of the American College of Cardiology* 2015;65:411-419. **CONTACT** Martijn.Maessen@radboudumc.nl

**INTELLIGENT PHYSICAL EXERCISE TRAINING PROVES EFFECTIVE IN ENHANCING MUSCLE STRENGTH AND REDUCING MUSCULOSKELETAL PAIN IN A WORKPLACE SETTING: A RANDOMIZED CONTROLLED TRIAL**

Dalager, T., Justesen, J.B., Sjøgaard, G.

*University of Southern Denmark*

**Background:** Physical exercise training interventions at the workplace may cause health benefits but not all employees may benefit from the same program despite having the same occupational exposure. The present aim was to individually tailor Intelligent Physical Exercise Training (IPET) for office workers based on health checks and to assess the effect on musculoskeletal health (Sjøgaard G et al. *BMC Public Health* 2014, 14:652). **Methods:** Office workers were at each of 6 companies randomized 1:1 to a training group, TG (N=194) or a reference group, REF (N=195). TG received one-hour supervised high intensity IPET every week within working hours for one year. The training program was based on baseline health check measures of muscle strength, musculoskeletal pain (self-reported on a 0-9 numeric box-scale), cardiorespiratory fitness and health risk indicators, as well as functional capacity including balance. In total 32 individual training programs were developed but 9 of those covered more than 85 % of the participants' needs, most of which included neck/shoulder strength training and cardio training. Trial registration was in ClinicalTrials.gov, number: NCT01366950. **Results:** There were no baseline differences between groups with overall mean±SD: shoulder elevation strength (right 494±173 N; left 478±171 N), arm abduction strength (right 250±101 N; left 244±102 N), neck pain (past 3 mth 3.2±1.9; 7 d 2.5±1.9), right shoulder pain (past 3 mth 2.4±1.7; 7 d 2.3±1.7), and left shoulder pain (past 3 mth 1.9±1.5; 7 d 2.0±1.5). An intention-to-treat analysis showed significant improvements for TG compared with REF in muscle strength with ~ 9 % increases (range: 3 % - 12 %), reduced neck pain past 7 d of 1.4±1.6, right shoulder pain past 3 mth of 0.6±1.4 and 7 d of 1.3±1.4, and left shoulder pain past 7 d of 1.1±1.0. Neck pain and left shoulder pain past 3 mth were found significant in a per protocol analysis among employees in TG with a compliance of ≥70 % compared with REF. Further, the proportion of employees who reduced pain intensity past 7 d with ≥1 was for all body regions ~ 90 % in TG and significant compared with REF (~ 20 %). **Discussion:** High intensity IPET during working hours significantly reduced musculoskeletal pain in neck and shoulders as well as increased muscle strength among office workers. Of note is the large proportion of employees in TG who had pain reductions of ≥1, which is considered of clinical relevance and was attained with different combinations of IPET. When targeting the workplace as a setting, it is important to not only address the occupational exposure but also to tailor the training to the diversity of the employees' capacity and disorders. E-mail: Tina Dalager - tdalager@health.sdu.dk

**CIGARETTE SMOKING INTERFERES WITH DIETARY NITRATE METABOLISM AND ITS EFFECTS ON BLOOD PRESSURE AND EXERCISE TOLERANCE**

Wylie, L.J.1, Blackwell, J.R.1, Jones, A.M.1, Bailey, S.J.1

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**Introduction** Cardiovascular diseases (CVDs) are the leading cause of mortality globally with cigarette smoking a major risk factor for the development of CVDs and the leading preventable cause of mortality worldwide. Increasing inorganic nitrate (NO<sub>3</sub><sup>-</sup>) intake can lower CVDs risk factors with the efficacy of NO<sub>3</sub><sup>-</sup> dependent on its uptake into the salivary circulation and subsequent reduction to nitrite (NO<sub>2</sub><sup>-</sup>) and nitric oxide (NO) (Kapil et al., 2014). Thiocyanate (SCN<sup>-</sup>), a competitive inhibitor of salivary NO<sub>3</sub><sup>-</sup> uptake (Edwards et al., 1954), is abundant in cigarette smoke. Therefore, this study tested the hypothesis that dietary NO<sub>3</sub><sup>-</sup> supplementation would increase salivary and plasma [NO<sub>3</sub><sup>-</sup>] and [NO<sub>2</sub><sup>-</sup>], lower BP and improve exercise tolerance to a lesser extent in cigarette smokers (S) than non-smokers (NS). **Methods** Nine (5 males) healthy S and eight (4 males) healthy NS controls reported to the laboratory for initial baseline assessment (CON) and following six day supplementation periods with 140 ml·day<sup>-1</sup> NO<sub>3</sub><sup>-</sup>-rich (8.4 mmol NO<sub>3</sub><sup>-</sup>·day<sup>-1</sup>; NIT) and NO<sub>3</sub><sup>-</sup>-depleted (0.08 mmol NO<sub>3</sub><sup>-</sup>·day<sup>-1</sup>; PLA) beetroot juice in a cross-over experiment. During each laboratory visit, resting blood pressure (BP) was assessed, saliva and venous plasma samples were collected, and a cycling incremental test to exhaustion was completed. **Results** Plasma and salivary [SCN<sup>-</sup>] were elevated in S compared to NS in all experimental conditions (P<0.05). Relative to CON, salivary [NO<sub>3</sub><sup>-</sup>] (3.5 ± 2.1 vs. 7.5 ± 4.4 mM), plasma [NO<sub>3</sub><sup>-</sup>] (484 ± 198 vs. 802 ± 199 μM) and plasma [NO<sub>2</sub><sup>-</sup>] (218 ± 128 vs. 559 ± 419 nM) increased with NIT in both S and NS,

but the magnitude of these increases was lower in S ( $P < 0.05$ ). Salivary [NO<sub>2</sub>-] was similarly increased above CON with NIT in S and NS ( $P > 0.05$ ). Systolic BP was lowered with NIT ( $100 \pm 10$  mmHg) relative to CON ( $107 \pm 7$  mmHg) and PLA ( $103 \pm 8$  mmHg) in NS ( $P < 0.05$ ), but not S ( $P > 0.05$ ). Peak aerobic power (AP<sub>peak</sub>) and oxygen uptake (VO<sub>2</sub><sub>peak</sub>) were not significantly impacted by NIT in S ( $P > 0.05$ ). In NS there was no difference in VO<sub>2</sub><sub>peak</sub> with NIT ( $P > 0.05$ ), but AP<sub>peak</sub> was higher in NIT compared to both PLA and CON ( $P < 0.05$ ). Discussion These findings suggest that the metabolism of dietary NO<sub>3</sub>- is compromised in S leading to attenuated blood pressure reductions and exercise tolerance gains relative to NS. These observations may provide novel insights into the cardiovascular risks associated with cigarette smoking and suggest that this population is less likely to improve cardiovascular health if they conform to global initiatives to increase fruit and vegetable consumption. References Kapil V, Weitzberg E, Lundberg JO, Ahluwalia A (2014). Nitric Oxide. 38, 45-57. Edwards DA, Fletcher K, Rowlands EN (1954). Lancet. 266, 498-499. Contact l.j.w221@exeter.ac.uk

## Invited symposia

### IS-BN04 QUALITY OF MOVEMENTS – MORE THAN MEETS THE EYE?

#### WHAT IS CLINICAL ASSESSMENT OF MOVEMENT QUALITY?

Crossley, K., Ageberg, E., Creaby, M.

*University of Queensland*

Altered movement patterns of the lower extremities after injury are common, but constitute a challenge to assess. Three-dimensional (3D) motion analysis is the gold standard for quantifying movements. However, clinically feasible measures are needed for large scale studies and clinical use. Visual observation of movement quality during functional tasks can be used for these purposes. One aspect of movement quality is postural orientation, which has received increased interest in recent years. Postural orientation is the ability to maintain an appropriate position of the joints in relation to each other and to the environment when performing a dynamic task. For example, in athletes with or at high risk of knee injury, the knee relative to the foot is often evaluated; a “knee-over-foot” position is considered appropriate, whereas a “knee-medial-to-foot” position is deemed inappropriate. In this talk I will present and discuss different approaches to how movement quality can be measured clinically, validity and reliability of clinical assessment of movement quality and the association between altered movement quality and injury

#### WHAT ARE THE SENSORIMOTOR AND BIOMECHANICAL MECHANISMS ASSOCIATED WITH GOOD AND POOR PERFORMANCE IN CLINICAL TESTS OF MOVEMENT QUALITY?

Creaby, M.W.

*Australian Catholic University*

In this talk I will present and discuss sensorimotor and biomechanical mechanisms associated with good and poor performance in clinical tests of movement quality. This will include data on links between poor movement quality, muscle size, strength, control, activation patterns, and gait mechanics. With links between movement patterns during clinical tests, such as a single leg squat, and sport-related lower limb injuries, an understanding of the mechanisms that contribute towards poor movement patterns during clinical tests is imperative. This knowledge may help in guiding the development of approaches to correct poor performance, and thus reduce the risk of future injury. This talk will draw on evidence from across the literature that highlights a consistency in movement patterns between clinical tests and sports specific skills such as running and landing. The likely importance of this consistency in movement patterns will be explained within the context of common acute and overuse knee injuries. Further, emerging evidence indicates that various modifiable factors may play an important role in the quality of movement, including muscle size, strength, control and activation patterns. Of particular interest, it is not just the local muscles that influence movement quality. For example, the lumbopelvic muscles are thought to play an important role in the quality of movement at the knee.

#### USING CLINICAL ASSESSMENT OF MOVEMENT QUALITY IN THE INJURY REHABILITATION AND RETURN-TO-SPORT

Ageberg, E.

*Lund University*

Single clinical tests are commonly used for assessing movement quality. Given that the responsiveness and discriminative ability are usually greater for several tests than for single tests, a test battery of functional tasks would be of value. Tasks with increased level of difficulty to be used at different stages after the injury, during the rehabilitation period, and for determining return to sports would be useful. Preventing a medial position of the knee is suggested to reduce the risk of traumatic knee injuries, especially in female athletes, and therefore forms an integral component of prevention and rehabilitation through neuromuscular training interventions. However, the possible influence of rehabilitation on movement quality has not yet been studied. Also, altered movement quality may be revealed in other body parts apart from the knee, e.g., the trunk, pelvis and hip, but this phenomenon requires further study. In this talk, I will present and discuss findings on selecting the appropriate clinical tests for assessing movement quality, the association of worse movement quality with symptoms, function, and gender and whether altered movements can improve by rehabilitation and predict the outcome after rehabilitation.

## Invited symposia

### IS-BN06 TENDON ADAPTATION

#### TENDON RESPONSE TO EXERCISE TRAINING

Bojsen-Møller, J.

*Norwegian School of Sports Sciences*

In vivo studies over the last decade has indicated that force transmitting tissues and/or their immediate surroundings respond instantly to sustained loading with increased blood flow and glucose uptake (Bojsen-Møller et al., 2006). Moreover, augmented collagen synthesis rate has been observed within hours to days of one strenuous exercise bout, and overall gains in collagen synthesis has been demonstrated in response to periods of exercise training (Langberg et al 2001). Taken together there seems to be firm evidence that tendinous tissues respond acutely to training induced loading. At the same time recent evidence suggests that human tendons or at least parts of human tendons exhibit an extremely slow turnover that in fact indicates that tendons are hardly renewed over the course of a lifetime (Heinemeier et al. 2013). Previous training studies on humans and animals have not been clear with respect to changes in tendon dimensions and mechanical properties, however, more recent evidence suggests that in fact tendon dimensions do increase after especially strength training, and also mechanical properties seem to change in response to habitual increases in loading (Couppe et al. 2008; Kongsgaard et al. 2007; Seynnes et al. 2009). Gains in imaging techniques, resolution and improved analyses are likely to have contributed to these newer findings. This presentation reviews the existing knowledge on tendon response to loading in an attempt to elucidate how the force bearing tissues adapt to habitual exercise training. References Bojsen-Møller J, Kalliokoski KK, Seppänen M, Kjaer M, Magnusson SP. (2006) Low intensity tensile loading increases intratendinous glucose uptake in the Achilles tendon. *J Appl Physiol* 101: 196-201. Couppé C, Kongsgaard M, Aagaard P, Hansen J, Bojsen-Møller J, Kjaer M, Magnusson SP. (2008). Habitual loading results in tendon hypertrophy and increased stiffness of the human patellar tendon. *J Appl Physiol* 105: 805-810. Heinemeier KM, Schjerling P, Heinemeier J, Magnusson SP, Kjaer M. (2013) Lack of tissue renewal in human adult Achilles tendon is revealed by nuclear bomb (14)C. *FASEB J. May*;27(5):2074-9. Kongsgaard M, Reitelseder S, Pedersen TG, Holm L, Aagaard P, Kjaer M, Magnusson SP. (2007) Region specific patellar tendon hypertrophy in humans following resistance training. *Acta Physiol*, 191, 111-121. Langberg H, Rosendal L, Kjaer M (2001). Training-induced changes in peritendinous type I collagen turnover determined by microdialysis in humans. *J Physiol*, 534.1, pp 297-302 Seynnes OR, Erskine RM, Maganaris CN, Longo S, Simoneau EM, Grosset JF, and Narici MV. (2009) Training-induced changes in structural and mechanical properties of the patellar tendon are related to muscle hypertrophy but not to strength gains. *J Appl Physiol* 107:523-530.

#### THE RELATIONSHIP BETWEEN TENDON MECHANICAL PROPERTIES AND DAILY STRESS LEVELS

Seynnes, O.

*Norwegian School of Sport Sciences*

Tendon composition and mechanical properties are often defined as a compromise between their functions for an effective force transmission to the skeleton and for the storage/release of elastic energy. Consistent with this paradigm, short-term studies have shown that alterations in tendon function via training results in metabolic and structural adaptations, which in turn may modify tendon material properties (1). However, cross-sectional comparisons from animal studies indicate comparable elastic moduli in tendons fulfilling different functions, independently from species and body mass (2, 3). Instead, results from these studies suggest that tendon cross-sectional area is the only parameter related to daily stress level. These findings are consistent with theoretical models placing tendon morphology and stiffness as principal variables of adjustment to daily stress levels, but they contrast with inconsistent reports of human tendon hypertrophy in training studies (4). This presentation will summarise - and attempt to conciliate - theoretical concepts of tendon long-term adaptation, based on the study of animal specimen and on in vivo testing of human tendons. 1. Heinemeier KM, Kjaer M. In vivo investigation of tendon responses to mechanical loading. *J Musculoskelet Neuronal Interact* 11: 115-23, 2011. 2. Ker RF, Wang XT, Pike AV. Fatigue quality of mammalian tendons. *J Exp Biol* 203: 1317-1327, 2000. 3. Pollock CM, Shadwick RE. Relationship between body mass and biomechanical properties of limb tendons in adult mammals. *Am J Physiol* 266: R1016-21, 1994. 4. Wiesinger H-P, Kösters A, Müller E, Seynnes OR. Effects of Increased Loading on In Vivo Tendon Properties: A Systematic Review. *Med Sci Sports Exerc* 2015. (Epub)

#### EFFECTS OF AGING AND DISUSE ON TENDON

Stenroth, L.

*University of Jyväskylä*

Aging is commonly associated with decreased loading of tendon tissue due to decreased physical activity and muscle strength. Thus, both aging and disuse are hallmarked by reductions in tendon loading, which leads to changes in tendon tissue composition and in mechanical/morphological properties (Magnusson et al., 2008; Reeves, 2006). In vivo human studies have shown that disuse alters tendon mechanical properties but the effects of aging are unclear. The relative contributions of the effects of aging and disuse in age-related modifications of tendon properties have been studied by examining master athletes with life-long physical activity background. These studies have not shown a significant effect of habitual high levels of physical activity on tendon mechanical properties (Couppe et al., 2014; Karamanidis and Arampatzis, 2006). However, tendons do respond to strength training even in old age (Reeves et al., 2003) indicating that loading type is important factor to be considered. Effects of aging and disuse on tendon dimensions are unclear and inconsistent with effects on mechanical properties suggesting that tendon material properties are altered with aging and disuse. Collagen cross-linking and non-collagenous matrix may play a significant role in these modifications. Recent studies on tendon micromechanics (Thorpe et al., 2013; Depalle et al., 2015) may provide a link between tendon matrix and whole tendon properties, by helping to explain some of the inconsistent findings and pointing out possible alterations in load transmission within tendon structures which are specific to aging or disuse. This presentation will concisely review the current literature to highlight similarities and differences between the effects of aging and disuse. Finally, functional consequences of the tendon adaptations with aging and disuse will be discussed. References Couppe C, Svensson R, Grosset J, Kovanen V, Nielsen R, Olsen M, Larsen J, Praet S, Skovgaard D, Hansen M, Aagaard P, Kjaer M, Magnusson S (2014). Age 36, 9665. Depalle B, Qin Z, Shefelbine S, Buehler M (2015). *J Mech Behav Biomed Mater* (in press) Karamanidis K, Arampatzis A (2006). *J Biomech* 39, 406-417. Magnusson P, Narici M, Maganaris C, Kjaer M (2008). *J Physiol* 586.1, 71-81.

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## Invited symposia

### IS-SH01 FEPSAC SYMPOSIUM - THE DEVELOPMENT OF EXPERTISE AND COMPETENCIES OF APPLIED SPORT PSYCHOLOGISTS IN EUROPE

#### THE PROFESSIONAL DEVELOPMENT OF THE ASP PRACTITIONER

Wylleman, P., de Caluwé, D., Reints, A.

*Vrije Universiteit Brussel*

Using a qualitative methodology 12 applied sport psychology (ASP) providers were questioned on the competences important (a) to the quality of ASP support service and (b) throughout the ASP practitioner career. First, respondents provided 57 different concepts which were subcategorized in (a) attitudes/beliefs competencies (e.g., flexibility, being part of sport culture, reticence, modesty); (b) knowledge competencies (e.g., clinical and other psychology disciplines, sport, sport psychology, sport sciences); and (c) skills including personal (e.g., creativity, mental skills, self-confidence), social/interpersonal (e.g., communication skills, networking), and therapeutic skills (e.g., empathy, individual counselling). Second, respondents felt novice professionals should acquire most attitudes/beliefs required (e.g., interest in people, openness, passion for/interest in sport, perseverance, modesty) as well as having self-knowledge, knowledge on how to (initiate) work with people and on mental skills. Knowledge of (the requirements of) sport was related to mature ASP practitioners. Counselling, communication and social/interpersonal skills were deemed important throughout the career. Diagnostic skills was more linked to the novice professional, while being able to work individually, use and learn from experience, and provide supervision were linked to the experienced professional. These findings will be used to enhance the education and professionalization of ASP providers.

#### WORKING EFFECTIVELY IN YOUTH SPORT: REFLECTIONS OF A LEAD SPORT PSYCHOLOGIST

Harwood, C.

*Loughborough University*

Childhood and Adolescence are key developmental stages within which to influence the growth of psychosocial skills and attributes in young sports performers. National Sport Federations and Professional sports academies are increasingly recognising the opportunity to employ sport psychologists in their programmes (Harwood, 2008). The sport psychologist in these settings face a range of challenges and a diversification of organisational roles given the number of stakeholders and policies to consider (i.e., coaches, parents, peers, funding). In this presentation, the Lead Psychologist (with 18 years of experience) of a National Federation and a Professional youth soccer academy will offer his reflections of the competencies required when working in youth sport settings. The synergy of humanistic and cognitive-behavioral approaches to sport psychology will be discussed given the significance of self-concept, self-identity and self-regulation to the health of the talented young person in sport. Additionally, the opportunity to develop strategic initiatives incorporating technology will be appraised. Finally, the ability to create effective working relationships within and between interdisciplinary support staff, coaches, and parents will be considered in light of a range of personal and organisational skills demanded of the practitioner. These reflections will sport scientists, researchers and young psychologist's insights into some of the real world issues facing psychologists.

#### BECOMING A COMPETENT PRACTITIONER IN SPORT PSYCHOLOGY: TYPICAL CHALLENGES AND EFFECTIVE LEARNING EXPERIENCES

Hutter, V.

*VU University Amsterdam*

As highlighted in the other presentations of this symposium, specific competencies are required for sport psychologists. Aspiring sport psychologists need to develop a wide range of skills and competencies to become effective professionals. Novice sport psychologists struggle with generic, typical issues and common challenges during their training and first professional steps. In sport psychology, first professional experience is usually obtained in a supervised practicum. Analyses of 369 questions that novice sport psychologists asked their supervisors during supervised practice resulted in a model of supervisory issues in applied sport psychology. These supervisory issues reflect which skills, competencies and aspects of service delivery are particularly difficult to master for novice sport psychologists. Next, novice sport psychologists were interviewed about the model's supervisory issues and were asked what learning experiences helped them resolve the supervisory issues and thus added to professional development. Qualitative analyses revealed the importance of different learning experiences inside, as well as outside education and classroom settings. From these results implications are drawn for the education and training of sport psychologists. The methodology used is applicable to the education and training of other professionals in sport sciences, and therefore of interest if educators in (applied) sport sciences.

#### 'FEPSAC SYMPOSIUM 'THE DEVELOPMENT OF EXPERTISE AND COMPETENCIES OF APPLIED SPORT PSYCHOLOGISTS IN EUROPE''

Johnson, U.

*Halmstad University*

Within the field of applied sport psychology (ASP) interest in professional practice is growing, and we are faced with the challenge of developing not only our professional status but also the competencies and level of expertise of providers. In three presentations, this symposium will highlight the latest research and the most salient aspects of ASP support provision in general, and the expertise and competencies required and used by ASP support providers, in particular. In the first presentation Professor Paul Wylleman from Free University, Brussels, Belgium will present "The Professional Development of the ASP Practitioner." Using a qualitative methodology, 12 ASP

providers were questioned about their competences. Respondents felt novice professionals should attempt to acquire self-knowledge, knowledge on how to (initiate) work with people, and competencies with mental skills. Knowledge of (the requirements of) sport was related to mature ASP practitioners. Counselling, communication, and social/interpersonal skills were deemed important throughout the career. Diagnostic skills was more linked to the novice professional, whereas being able to work individually, use and learn from experience, and provide supervision were linked to the experienced professional. In the second presentation Associate Professor Chris Harwood from Loughborough University, England will present, "Working Effectively in Youth Sport: Reflections of a Lead Sport Psychologist." Childhood and adolescence are key stages within which psychosocial skills and identity are developing in young sports performers. In this presentation, the Lead Psychologist (with 18 years of experience) of a National Federation and a professional youth soccer academy will offer his reflections of the competencies required when working in youth sport settings. The synergy of humanistic and cognitive-behavioral approaches to sport psychology will be discussed along with the significance of self-concept, self-identity, and self-regulation to the health of the talented young person in sport. In the third presentation Dr Vana Hutter from University Amsterdam, the Netherlands will present "Becoming a Competent Practitioner in Sport Psychology: Typical Challenges and Effective Learning Experiences." Novice sport psychologists struggle with many challenges during their training and first professional steps. Analyses of 369 questions, which novice sport psychologists asked their supervisors during supervised practice, resulted in a model of supervisory issues in applied sport psychology. From this model implications are drawn for the education and training of sport psychologists. The methodology used is applicable to the education and training of other professionals in sport sciences, and therefore of interest to educators in (applied) sport sciences. Professor Urban Johnson from Halmstad University, Sweden will chair the session.

## Invited symposia

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### IS-SH02 ANIMALS, SPORT AND HEALTH - A SUSTAINABLE RELATIONSHIP?

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#### YOUTH EQUESTRIAN SPORT: INTERSPECIES RELATIONS IN TIME AND SPACE

Gillet, J.

*MacMaster University*

The purpose of this lecture is to explore the changes in youth equestrian sport that have occurred in Canada since the introduction of the pony club in 1934. I argue that before the 1980's equestrian sport served, for women, many of the same purposes as bicycling and golf. It was emancipatory and liberating while safely within the culturally acceptable confines of the privileged group. Beginning in the late 1970's and early 1980's, a shift towards neoliberal economic logic led to social and cultural changes in Canada. In sport, there was a movement away from volunteer sport organizations towards private forms of organized sport. These changes were reflected in the equine industry as the role and perceived utility of the Canadian pony club began to change. This late modern shift created a market for sport and encouraged the privatization of equestrian sport. Today members of the equestrian community contest the value of pony club as a youth sport. The organization still offers cultural capital through education and training but in a late modern society its ability to produce capital through competition has declined due to the introduction of new equestrian sport organizations and changes in the consumption of sport.

#### THE HORSE AS A HEALTH WORKER?

Sörensen, M.

*Norwegian School of Sport Sciences*

The horse as a health worker? Introduction Several studies have demonstrated health benefits in humans from contact with animals, but most studies in this area have been on smaller pets like dogs and cats. The purpose of this study was to investigate the associations between human health and contact with horses. The specific research question was: Are there any differences between individuals who have regular contact with horses, those who have occasional contact and those who have no contact with horses on indicators on physical and psychological health? Methods Data come from a population survey by questionnaire and health examinations by the National Health Institute in Norway in cooperation the municipalities in two counties in the years of 2001 – 2002. Around 4450 participants answered the questions related to work related or leisure time contact with horses (Small variations in N for the different questions). Due to consistent gender differences, data were analysed for each gender separately. Results Preliminary analyses indicated differences in reported health indicators both between genders but also between having contact with horses professionally and in leisure time as well as between those who had contact with horses occasionally, and those who were in contact with horses on a regular basis (weekly or daily). Males with contact with horses both in leisure time and professionally reported more skeletomuscular pain, but were more physically active than those with no contact, and those with a regular contact demonstrated lower blood pressure than the others. Females with regular horse contact in leisure time, reported less psychological problems than the others. Females with horse contact both professionally and in leisure time were more physically active and demonstrated lower blood pressure than those with no horse contact. Discussion Contact with horses seems to have both its benefits and costs, and some of them are similar for the genders, but others differ. One common trend is that contact with horses seem to make people more physically active, but that in particular for men in this population, it may also mean hard work that is associated with more skeletomuscular pain. This may be related to differences in how men and women work with or use horses in leisure time. The tendency of women with regular leisure time horse contact to report less psychological problems than those with no or occasional contact could be explained with the need for a certain frequency of contact for psychological benefits. Contact [marit.sorensen@nih.no](mailto:marit.sorensen@nih.no)

#### ETHICS IN HORSE RIDING

Dashper, K.

*Leeds Metropolitan University*

The riding of horses for human sport and pleasure is a controversial issue. Unlike human participants, horses cannot give informed consent to take part in these activities and are necessarily in a subordinate position in relation to their human rider who (a) understands the terms of engagement in the sport or leisure activity, (b) can choose to take part in the activity, or not, and (c) can choose to cease



participation at any point. But does this make the involvement of horses in human pleasure inherently unethical? In this presentation I draw on data from two linked studies – one with professional riders and one with leisure of amateur riders – to consider this issue in more detail. Through riding the horse is subject to human will but this does not mean that the horse lacks agency in these human-animal relationships. The participants in my research think and care deeply for the horses with whom they interact, although these interactions are influenced by the varying demands of the sport or leisure context in which they take place. I argue that whether or not it is ethically acceptable for humans to ride horses is a complex issue and one that riders at different levels consider daily in their interactions with their equine partners.

## Oral presentations

### OP-PM05 Muscle Metabolism & Nitrate Ingestion

#### CELLULAR MECHANISMS OF VITAMIN D IN SKELETAL MUSCLE REPAIR: A LIVE CELL IMAGING ANALYSIS

Owens, D., Polydorou, I., Alwan, N., Fraser, F., Tang, J., Morton, J., Sharples, A., Stewart, C., Close, G.

*Liverpool John Moores University*

**Purpose:** Association studies have demonstrated a correlation between Vitamin D status and muscle force recovery following damaging exercise (Barker, Henriksen, et al., 2013; Barker, Schneider, Dixon, Henriksen, & Weaver, 2013). The present study investigated vital cellular aspects of the regeneration process to establish a causal relationship between Vitamin D and skeletal muscle repair. **Methods:** Muscle biopsy samples were obtained from the Vastus Lateralis of 14 young males with Vitamin D concentrations <50 nmol.L<sup>-1</sup>. Muscle derived cells (MDCs) were isolated from biopsies, characterised by immunocytochemistry and cultured to confluence prior to mechanical scrape damage (Dimchev, Al-Shanti, & Stewart, 2013) in the presence of vehicle (CON), 10 nmol (Lo) or 100 nmol (Hi) 1 $\alpha$ 25-dihydroxyvitamin D<sub>3</sub>, the biologically active form of Vitamin D. MDC migration velocity (V), accumulated (AD) and Euclidean distance (ED) and directionality (DIR) were assessed via live cell imaging over 48hrs following injury. **Results:** Live cell imaging analysis revealed significant improvements (P < 0.05) in V for Lo (0.30  $\pm$  0.10  $\mu$ m.min<sup>-1</sup>), and Hi (0.32  $\pm$  0.11  $\mu$ m.min<sup>-1</sup>) vs CON (0.2  $\pm$  0.1  $\mu$ m.min<sup>-1</sup>). Similar significant improvements (P < 0.05) were seen for AD (858  $\pm$  290, 909  $\pm$  315 vs 691  $\pm$  326  $\mu$ m) and ED (459  $\pm$  204, 450  $\pm$  204 vs 339  $\pm$  203  $\mu$ m in Lo & Hi vs CON). **Conclusions:** Our data provide the first insights into the cellular mechanisms by which Vitamin D deficiency may impair muscle regeneration. These findings warrant further investigation into the molecular signalling mechanisms dictating such changes in human muscle cell behaviour in the context of Vitamin D. Moreover, populations in which muscle regeneration may already be impaired (i.e. elderly or dystrophic) require research efforts to explore the possibility that Vitamin D deficiency exacerbates existing regenerative dysfunction. **References -** Barker, T., Henriksen, V. T., Martins, T. B., Hill, H. R., Kjeldsberg, C. R., Schneider, E. D., . . . Weaver, L. K. (2013). Higher serum 25-hydroxyvitamin D concentrations associate with a faster recovery of skeletal muscle strength after muscular injury. *Nutrients*, 5(4), 1253-1275. doi: 10.3390/nu5041253 - Barker, T., Schneider, E. D., Dixon, B. M., Henriksen, V. T., & Weaver, L. K. (2013). Supplemental vitamin D enhances the recovery in peak isometric force shortly after intense exercise. *Nutr Metab (Lond)*, 10(1), 69. doi: 10.1186/1743-7075-10-69 - Dimchev, G. A., Al-Shanti, N., & Stewart, C. E. (2013). Phospho-tyrosine phosphatase inhibitor Bpv(Hopic) enhances C2C12 myoblast migration in vitro. Requirement of PI3K/AKT and MAPK/ERK pathways. *J Muscle Res Cell Motil*, 34(2), 125-136. doi: 10.1007/s10974-013-9340-2

#### DIURNAL DIFFERENCES IN THE MYOFIBRILLAR PROTEOME OF HUMAN VASTUS LATERALIS

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**Introduction** The ability of skeletal muscle to produce force is significantly greater in the evening than in the morning. However, the mechanisms underpinning this diurnal variation have not been resolved. The protein complement (i.e. proteome) of muscle underpins its functional properties; therefore we reasoned the diurnal difference in performance is associated with changes in muscle myofibrillar proteins. **Methods** Ten physically active men (mean  $\pm$  SD; age 26.7  $\pm$  3.7 y, height 1.77  $\pm$  0.08 m, body mass 74.9  $\pm$  9.8 kg) completed the protocol after providing informed consent to the ethically approved procedures. Participants were familiarised prior to performing experimental sessions in the morning (0800 h) and evening (1700 h) that were counterbalanced in order of administration and separated by at least 72 h. Each session included 5 min cycling at 150 W, 4 measurements of maximal voluntary contraction (MVC; including twitch-interpolation) and 10 measurements of the maximum rate of force development (RFD) of their knee extensors. Muscle samples were then collected under local anaesthetic (0.5 % Marcain) by percutaneous needle biopsy from the vastus lateralis of the exercised leg. Myofibrillar proteins were resolved by 2-dimensional gel electrophoresis. Gels images were analysed in SameSpots (TotalLab v3.3) and proteins identified by mass spectrometry. Statistical analysis was conducted by repeated measures one-way analysis of variance. **Results** Muscle force in the evening (754.4  $\pm$  112.9 N/m) was significantly (P<0.01) greater (11 %) than in the morning (679.9  $\pm$  104.9 N/m). RFD was also significantly (P<0.01) greater (15.7 %) in the evening (7030.5  $\pm$  1100.7 N/s) than in the morning (6077.3  $\pm$  1371.7 N/s). In total, 122 proteins were analysed and the abundance of 8 spots was statistically (P<0.05) different from morning to evening. In the evening greater abundances were observed in myosin binding protein C1 (80 %), glycogen phosphorylase (43 %) and beta enolase (24 %), whereas the abundances of nebulin (-48 %), troponin T slow (-22 %), and 3 spots identified as keratin II (average -30 %) was less in the evening compared to morning. **Discussion** The diurnal variation in muscle performance was associated with significant differences in the myofibrillar proteome. The slow isoform of myosin binding protein C (MyBPC1) exhibited the greatest difference and is known to modulate the activity of actin-bound myosin ATPases. MyBPC1 was resolved to 6 species, therefore the difference in abundance reported here may represent a change in post-translational modification. Contact Z.Ab-Malik@2011.ljmu.ac.uk

**INFLUENCE OF BEETROOT JUICE AND SODIUM NITRATE ON OXYGEN CONSUMPTION IN TRAINED MEN**

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**Introduction:** The influence of dietary nitrate such as beet root juice (BR) on exercise performance is controversially discussed in sport science these days. It was shown, that nitrate may reduce oxygen consumption (VO<sub>2</sub>) during exercise (Bailey et al., 2009; Vanhatalo et al., 2010; Wylie et al., 2013). To date, it is not clear, if the ingestion of sodium nitrate (NIT) shows the same effect on VO<sub>2</sub> as BR. Secondly, it remains unclear, whether the same dose of NIT leads to similar plasma nitrate ([NO<sub>3</sub>-]) and nitrite ([NO<sub>2</sub>-]) concentrations as BR. The aim of our study was to investigate the influence of different dosages of BR and NIT on VO<sub>2</sub> and on plasma [NO<sub>3</sub>-] and [NO<sub>2</sub>-]. **Methods:** Ten healthy, trained men (median [minimum; maximum]; age: 33years [19; 46]; height: 182cm [170; 187]; body mass: 73.5kg [60.7; 78.0] and VO<sub>2</sub>peak: 60.2ml/min/kg [40.5; 67.0]) participated in this study. Subjects completed seven trials of 5min cycling at 50% VO<sub>2</sub>peak followed by 8min cycling at 80% VO<sub>2</sub>peak. 3 hours before each trial, subjects ingested either a dosage of BR (3, 6 or 12mmol), of NIT (3, 6 or 12mmol) or placebo (PLC, plain water) in a random order. Blood samples were taken before and 3 hours post-ingestion for [NO<sub>3</sub>-] and [NO<sub>2</sub>-] analysis. Gastrointestinal tolerance was recorded. **Results:** Exercise at 50% VO<sub>2</sub>peak showed no significant differences in VO<sub>2</sub> between the trials (p=0.186), whereas exercise at 80% VO<sub>2</sub>peak showed a significantly lower VO<sub>2</sub> (p=0.050). Significant differences between the 6mmol BR and the PLC (p=0.028) trial as well as between the 6mmol BR and NIT trial (p=0.008) were found. Plasma [NO<sub>3</sub>-] and [NO<sub>2</sub>-] were significantly increased 3 hours post-ingestion of nitrate compared to PLC (p<0.001). The comparison of plasma [NO<sub>3</sub>-] and [NO<sub>2</sub>-] between the same dosage of BR and NIT showed no significant differences for 6 and 12mmol. Gastrointestinal tolerance did not differ between interventions (p=0.172). **Discussion:** Our study results showed a significantly lower VO<sub>2</sub> in severe-intensity exercise after consumption of nitrate. The ingestion of 6mmol BR induced a significantly lower VO<sub>2</sub> compared to PLC. Astonishingly, the ingestion of 6mmol BR showed a significantly lower VO<sub>2</sub> compared to the NIT trial. In contrast, plasma [NO<sub>2</sub>-] showed no significant differences between these two dosages 3h post-ingestion. **References:** Bailey SJ, Winyard P, et al. (2009). *J of Appl Physiol*, 1144-1155. Vanhatalo A, Bailey SJ, et al. (2010). *Am J Physiol Regul Integr Comp Physiol*, R1121-1131. Wylie LJ, Kelly J, et al. (2013). *J Appl Physiol* (1985), 325-336. Contact: joelle.flueck@paraplegie.ch

**EFFECTS OF ACUTE VERSUS 6-DAY SODIUM NITRATE SUPPLEMENTATION ON TIME-TRIAL PERFORMANCE IN TRAINED CYCLISTS**

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**BACKGROUND:** Previous work has shown that ~6 days of dietary nitrate (NO<sub>3</sub>-) supplementation can lower oxygen uptake (VO<sub>2</sub>) during submaximal cycling exercise, and improve exercise performance in trained cyclists [1]. More recently, it was reported that even ingestion of a single dose of dietary nitrate prior to exercise can improve subsequent performance [2]. The purpose of this study was to compare the impact of acute versus 6-day sodium nitrate supplementation on oxygen uptake during submaximal exercise as well as time-trial performance in highly trained cyclists. **METHODS:** Using a randomized, double blind, cross-over design, 17 male cyclists (25±1 y, VO<sub>2</sub>peak 65±1 mL/kg/min, Wmax 411±9 W) were subjected to 3 different trials, including 6 days of sodium nitrate supplementation (6-DAY); 5 days of placebo and 1 day of sodium nitrate supplementation (1-DAY); 6 days placebo supplementation (PLA). Nitrate was administered as sodium nitrate (1.1 g NaNO<sub>3</sub>), providing ~12.9 mmol NO<sub>3</sub>-/day. Placebo consisted of 1.1 g sodium chloride per day. On the last day of each supplementation period and 3 h after consuming the last supplement, subjects performed 30 min of exercise at 45% Wmax and 30 min at 65% Wmax on a cycle ergometer, followed by a simulated ~10 km time-trial. Indirect calorimetry was performed during submaximal exercise, and blood samples were drawn up to 5 h following ingestion of the last supplement. Data were analyzed using repeated measures ANOVA with time and treatment as within-subjects factors. **RESULTS:** Plasma nitrate and nitrite concentrations increased from baseline to 3 h post-ingestion of the nitrate-containing supplements, resulting in significantly higher plasma nitrite levels immediately before exercise in both the 6-DAY and 1-DAY trial when compared with the PLA trial (501 ± 50 nM and 553 ± 67 nM versus 239 ± 18 nM, respectively; P<0.001). Time-trial performance (1004±15, 1022±17, 1017±17 s) and power output (316±9, 310±9, 312±9 W) were not significantly different between the 6-DAY, 1-DAY, and PLA trials, respectively (P=0.28 and P=0.33, respectively). No significant differences in submaximal VO<sub>2</sub> were observed during exercise at the 45% (2.56±0.06, 2.58±0.07, 2.54±0.06 L/min) and 65% Wmax workload (3.53±0.08, 3.51±0.09, 3.51±0.09 L/min) in the 6-DAY, 1-DAY and PLA trial, respectively (P=0.60 and P=0.89, respectively). **CONCLUSION:** Acute and 6-day sodium nitrate supplementation (~12.9 mmol NO<sub>3</sub>-/day) do not improve time-trial performance in highly trained cyclists. 1. Cermak, N., et al. *Med Sci Sports Exerc*, 2011, 22(1): p. 64-71. 2. Wylie, L.J., et al. *J Appl Physiol* (1985), 2013, 115(3): p. 325-36. Supported by a grant from the Dutch Technology Foundation STW

**EFFECTS OF BLOOD DONATION AND NITRATE INGESTION ON THE PHYSIOLOGICAL RESPONSE TO MODERATE-INTENSITY AND INCREMENTAL EXERCISE**

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**Introduction** Nitrate-rich beetroot juice (BR) can reduce the oxygen (O<sub>2</sub>) cost of moderate-intensity exercise and enhance tolerance to severe-intensity exercise (Bailey et al., 2009). A derivative of nitrate (NO<sub>3</sub>-), nitric oxide, plays a significant role in the regulation of skeletal muscle blood flow, contraction and efficiency. A reduction in blood O<sub>2</sub> carrying capacity, as a result of blood donation, reduces the tolerance to severe-intensity exercise (Burnley et al., 2006). The aim of this study was to determine whether BR supplementation alters the haemodynamic response, efficiency and tolerance to cycling exercise post blood donation. **Methods** In a randomised and double blind experimental design, 22 recreationally active volunteers performed moderate-intensity and ramp incremental cycle exercise tests prior to and post withdrawal of ~450 mL of whole blood. Before donation, all subjects (n=22) consumed 7 x 70 mL of NO<sub>3</sub>--depleted beetroot juice shots (~0.04 mmol NO<sub>3</sub>- per 70mL) as a placebo (PL) in the 48 h preceding the exercise tests. Immediately after blood donation and during the 48 h prior to exercise, subjects consumed 7 shots of either BR (~6.2 mmol NO<sub>3</sub>- per 70 mL; n=11) or PL (n=11). Blood pressure (BP), plasma NO<sub>3</sub>- and nitrite (NO<sub>2</sub>-) concentrations, haemoglobin concentration ([Hb]), haematocrit (Hct) and pulmonary V'O<sub>2</sub> responses to exercise were measured during each visit to the laboratory. **Results** BR supplementation resulted in an increased plasma [NO<sub>3</sub>-] (PL: 50±14 vs. BR: 845±350 µM; P<0.05) and [NO<sub>2</sub>-] (PL: 72±21 vs. BR: 619±363 nM; P<0.05) post blood donation. Systolic BP was reduced in BR post blood donation when compared with baseline. [Hb] and Hct decreased significantly from pre to post blood withdrawal, however, no difference was noted between PL and BR. Compared with pre donation, the steady state V'O<sub>2</sub> during moderate-intensity exercise was

~4% lower post donation in BR only ( $P < 0.05$ ). The ramp test peak power decreased from pre donation (PL:  $341 \pm 70$  vs. BR:  $331 \pm 68$  W) to post donation (PL:  $324 \pm 69$  vs. BR:  $322 \pm 66$  W) in both groups ( $P < 0.05$ ). However, the decrement in performance was less in BR compared with PL ( $P < 0.05$ ). Discussion Nitrate supplementation reduces the O<sub>2</sub> cost of moderate-intensity exercise and lessens the decline in ramp incremental performance after blood donation. The results from this study may have implications for improving functional capacity in conditions where normal blood O<sub>2</sub> carrying capacity is impaired. References Bailey SJ, Winyard P, Vanhatalo A, Blackwell JR, DiMenna FJ, Wilkerson DP, Tarr J, Benjamin N, Jones AM. (2009). *J Appl Physiol*, 107, 1144-1155 Burnley M, Roberts CL, Thatcher R, Doust JH, Jones AM. (2006). *Exp Physiol*, 91, 499-509 Contact stjrm201@exeter.ac.uk

### LOW MUSCLE GLYCOGEN IMPAIRS POST-EXERCISE P70S6K ACTIVITY DESPITE HIGH LEUCINE AVAILABILITY: THE CRITICAL GLYCOGEN HYPOTHESIS

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**Introduction** Reduced carbohydrate (CHO) availability during training augments mitochondrial biogenesis (Bartlett, et al. 2015) and ingestion of leucine rich protein elevates (Pasiakos et al. 2011) muscle protein synthesis (MPS). We tested the hypothesis that reduced CHO but simultaneous high leucine availability enhances cell signalling responses associated with regulation of mitochondrial biogenesis and MPS. **Method** In a repeated measures crossover design, eleven males completed an exercise-nutrition protocol to modulate muscle glycogen prior to completing 45 min cycling at 50% peak power output (PPO) followed by an exercise capacity test (1-min bouts at 80% PPO interspersed with 1-min bouts at 40% PPO) in conditions of high CHO and protein availability (HIGH) or low CHO but high protein (leucine enriched) availability (LOW). Vastus lateralis biopsies were obtained pre-, post- and 3 h post-exercise to assess muscle glycogen content and activity of p70S6K, AMPK and PKB using kinase assays. Two way RM ANOVA was used to compare differences between conditions and across time. **Results** Muscle glycogen was different ( $P < 0.05$ ) pre-exercise (HIGH:  $583 \pm 158$ , LOW:  $271 \pm 84$  mmol/kg), similar post-exercise (HIGH:  $114 \pm 72$ , LOW:  $85 \pm 59$  mmol/kg) and different ( $P < 0.05$ ) 3 h post-exercise (HIGH:  $216 \pm 132$ ; LOW:  $116 \pm 60$  mmol/kg). Despite differences ( $P < 0.05$ ) in exercise capacity (HIGH:  $98 \pm 29$ , LOW:  $40 \pm 17$  min), exercise increased AMPK ( $P < 0.05$ ) at exhaustion in both groups (HIGH:  $6 \pm 4$ , LOW:  $9 \pm 5$  mU/mg). In accordance with elevated leucine availability in LOW, p70S6K activity was different ( $P < 0.05$ ) pre-exercise (HIGH:  $45 \pm 23$ , LOW:  $65 \pm 24$   $\mu$ U/mg) whilst exercise suppressed activity at exhaustion (HIGH:  $22 \pm 16$ , LOW:  $22 \pm 13$   $\mu$ U/mg). However, despite elevated leucine availability post-exercise in LOW, PKB activity was reduced ( $P < 0.05$ ) at 3h in LOW (HIGH  $49 \pm 24$ , LOW  $29 \pm 6$   $\mu$ U/mg) accordingly p70S6K activity was not restored at 3 h post-exercise (HIGH:  $53 \pm 38$ , LOW:  $28 \pm 14$   $\mu$ U/mg). **Discussion** We show for the first time that the post-exercise recovery of p70S6K activity is impaired when muscle glycogen remains low despite high leucine availability. Although reduced CHO availability augments mitochondrial adaptations, we also suggest that post-exercise glycogen stores should not remain depleted ( $< 150$  mmol/kg) to restore activity of p70S6K; we suggest there is a 'critical glycogen threshold' below which remodelling is impaired following exercise. Athletes should minimise time spent below this threshold during periods of low CHO training to augment the adaptive response to training. References Bartlett JD et al. (2015). *Eur J Sport Sci* 15: 3 – 12. Pasiakos SA et al. (2011). *Am J Clin Nutr* 94: 809 – 818 .

## Oral presentations

### OP-BN01 Neuromuscular Control

#### VISCOELASTIC CONTROL FOR HUMAN STANDING

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**Introduction** Human stable standing needs complicated control of joint torques sustainably. The viscoelasticity which is stiffness and viscosity resulted intrinsically from muscles, tendons, and ligament gives the stability and may reduce the liability of the central nervous system (CNS). The purpose of this study is to determine the multi-directional postural control based on viscoelastic ellipses. **Methods** Five subjects stood on the force platform on the disturbance machine, and maintained standing against the disturbance. The displacement, velocity and acceleration of the disturbance were 50mm, 500mm/s, and 0.6G, respectively. The directions were equally distributed in 30° increments to evenly cover the entire horizontal plane and were selected at random. During tasks ground reaction force (GRFs) and surface electromyogram (EMG) of lower limbs were recorded. The Viscoelastic ellipse was calculated from GRFs data by means of a second-order model (Tsuji et al., 1995). **Results & Discussion** The major axis of ellipses fitted in the direction of each disturbance, suggesting that humans stabilize their posture of standing by the resisting force resulted from stiffness and viscosity in response to the disturbance. To my knowledge, this is the first study examining the impedance of the lower limbs during human standing. The length of the major axis of ellipses, which represents the magnitude of the maximal stiffness and viscosity, was long in the front-back and lateral disturbance directions. This result indicates that human standing has relatively large viscoelasticity in the front-back and lateral directions. On the other hand, the major axis of ellipses was short in the diagonal disturbance directions. From a result of the analysis of EMG data, many muscles had the preferred directions in the diagonal directions as if the lowness of viscoelasticity in the diagonal directions was compensated. These results suggest that (1) the most of the total torque to need the postural control are produced by the passive torque resulting from the viscoelasticity, and (2) the postural control generated by viscoelasticity depends on the disturbance directions of bipedal posture. References Tsuji T, Morasso PG, Goto K, Ito K. (1995). *Biol Cybern*, 72: 475-485. Contact s.tomidada@gmail.com

#### EFFECTS OF ALPINE SKIING ON PATELLAR TENDON PROPERTIES IN OLDER PATIENTS WITH TOTAL KNEE ARTHROPLASTY

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**Introduction** Total knee arthroplasty (TKA) is a common and efficient surgical procedure in patients with knee joint disorders. The procedure is accompanied by alterations of knee geometry (Ward et al., 2012), with under-investigated implications for the patellar tendon loading and properties despite the essential role of tendinous function in daily activities. Hence, the aim of the study was to investigate

the side-to-side difference in patellar tendon properties of TKA patients and ii) to analyse the training responsiveness of the tendon in operated (OP) and non-operated (NOP) legs. With alpine skiing, we chose a physical activity that enhance patients' health and life-style (Müller et al., 2011), while being an effective means to safely increase tendon loading (Seynnes et al., 2011). Method Thirty-one adults (70.4 ± 4.7 yrs) with unilateral TKA were recruited 2.7 ± 0.9 years after surgery and assigned to an intervention (IG) or a control group (CG). The IG underwent a 12-week supervised skiing program, while the CG did not change their daily routines. Patellar tendon stiffness, Young's modulus and CSA were measured before and after the intervention, with combined ultrasonography and dynamometry. Results In both groups, mean tendon CSA was 28% (P<.001) larger in the OP than in the NOP leg at baseline, without any difference in other tendon properties. Tendon stiffness in IG subjects was 5.8% and 15.8% larger, respectively, in the OP and NOP legs. Likewise, mean CSA increased in the IG by 2.9% in the OP and 3.8% in the NOP leg, whereas no significant changes were found for the Young's modulus. None of the tendon parameters changed in the CG. Discussion The present results suggest that patellar tendon loading patterns are altered following TKA, inducing changes in morphological and mechanical properties. Yet tendinous tissue seems to retain its adaptation capacity in these patients. Further, alpine skiing appears to offer a suitable rehabilitation strategy for TKA patients. References Müller E, Gimpl M, Poetzelsberger B, Finkenzeller T, Scheiber P (2011). Salzburg Skiing for the Elderly Study: study design and intervention – health benefit of alpine skiing for elderly. *Scand J Med Sci Sports*, 21 (Suppl. 1), 39-46. Ward TR, Pandit H, Hollinghurst D, Moolgavkar P, Zavatsky AB, Gill HS, et al. (2012). Improved quadriceps' mechanical advantage in single radius TKRs is not due to an increased patellar tendon moment arm. *Knee*, 19(5), 564-570. Seynnes OR, Kösters A, Gimpl M, Reifberger A, Niedersser D, Niebauer J, et al. (2011). Effect of alpine skiing training on tendon mechanical properties in older men and women. *Scand J Med Sci Sports*, 21 (Suppl. 1), 39-46. Contact: hans-peter.wiesinger@sbg.ac.at

### EFFECTS OF DIFFERENT STRETCHING TECHNIQUES ON MUSCLE- AND TENDON PROPERTIES

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Introduction The three most common stretching methods are static, ballistic, and proprioceptive neuromuscular facilitation (PNF) stretching (Magnusson et al. 1996). Many studies have shown an increase in range of motion (RoM) following a stretching training for several weeks. However, it is not yet well understood if structural adaptations of the muscle-tendon-unit (MTU) could be responsible for the observed increase in RoM. Therefore, the purpose of this study was to investigate the effects of a six-week stretching training with the different stretching techniques on the MTU of the gastrocnemius medialis (GM). Furthermore, we determined if there is any difference between the effects of the most common stretching methods. We hypothesized a gain in RoM and adaptations in the MTU (e.g. more compliant tendon and/or muscle tissue) in all three stretching techniques. Moreover, we expected different functional and structural adaptations in the three stretching techniques. Methods Sixty-eight healthy male (mean ± SD; 23.4±2.6 years, 179.9±5.6cm, 77.2±7.7 kg) and 30 healthy female (mean ± SD; 22.9±3.3 years, 170.5±4.8cm, 62.5±5.7 kg) police cadets participated in the studies. They were randomly assigned to a static stretching group (n=25), a ballistic stretching group (n=24), a PNF stretching group (n=25), and a control group (n=24). Before and after the six-week intervention, the RoM, passive resistive torque, maximum voluntary contraction, and several parameters of the muscle and tendon structures (e.g. muscle stiffness, tendon stiffness, pennation angle, fascicle length) of the GM were determined with a dynamometer and ultrasound. To test the effects of the stretching interventions paired t-tests were used. Differences between the effects of the three stretching techniques were tested with MANOVAs. Results Whereas no adaptations were found in the control group, there was an increase in RoM due to static stretching from 30.9° to 36.3° (p=0.00), due to ballistic stretching from 33.8° to 37.8° (p=0.00), and due to PNF stretching from 31.1° to 33.1° (p=0.02). However, only in the PNF stretching group the increased RoM could be partly explained by decreasing active (p=0.04) and passive (p=0.01) tendon stiffness and increasing pennation angle (p=0.01). MANOVAs showed no significant different effects of the three stretching techniques. Discussion Based on the results of this study the major reason for the increase in RoM in all stretching techniques is more likely an altered perception of stretch and pain or stretch tolerance (Magnusson et al. 1996), than a structural adaptation of the MTU. References Magnusson S.P.; Simonsen E.B.; Aagaard P.; Dyhre-Poulsen P.; McHugh M.P.; Kjaer M. (1996) Mechanical and physical responses to stretching with and without preisometric contraction in human skeletal muscle. *Arch Phys Med Rehabil*, 77: 373–378.

### INTERMITTENT CONTROL OF TIPTOE STANDING: POSTURAL ROBUSTNESS BASED ON JOINT VISCOELASTICITY

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Introduction Tiptoe standing is easily destabilized due to its narrow base of support, and its robust control strategies are an attractive theme for balance control training. Joint coordination of human body segments during bipedal standing has been reported to change due to factors such as aging and training. The questions of whether this plasticity is the outcome of the change in passive joint properties (that is, joint viscoelasticity), and whether the change in postural robustness is caused by changes in joint viscoelasticity or control strategies, are still unsolved and cannot be answered experimentally. Our objective is to investigate whether joint viscoelasticity and joint control strategies affect joint coordination and the robustness of the model by creating a quadruple inverted pendulum with intermittent control as a model of tiptoe standing in the sagittal plane. Methods We simulated the motion of a quadruple inverted pendulum model for four links representing metatarsophalangeal (MP)-ankle, ankle-knee, knee-hip, and head-arm-trunk segments in the sagittal plane during tiptoe standing. We set three kinds of simulation parameters: three pairs of passive viscoelasticity coefficients, three kinds of joint control strategies for each joint (continuous active control, intermittent control, and no active control), and two values of  $\alpha$  representing the switching boundary for intermittent control. We assumed that the active torques are generated by linear PD feedback controllers with a delay of 200 ms. First, we validated our model by comparing the time series of angular displacements of simulation data with those from experiments with seven female participants from our previous study. Then we investigated the pairs of simulation parameters that stabilized the inverted pendulum and the differences in postural robustness between those pairs by examining the region of active feedback gain  $P$ . Results Among 480 pairs of simulation parameters, we found that 30 pairs stabilized the quadruple inverted pendulum; the amplitude and frequency characteristic of angular displacements of these pairs were similar to those of experiment data. For all of the 30 pairs, the hip was controlled intermittently, and the MP joint was either controlled intermittently or not actively controlled. Also, the simulation parameters (viscoelasticity, utilization of the stable manifold of the system, and joint control strategy) affected joint coordination patterns and the robustness of the model. Discussion In this study, we first found the plausible joint viscoelasticity coefficients of tiptoe standing by making the fluctuation of the inverted pendulum similar to actual human body fluctuations. The robustness of our model varied depending on joint viscoelasticity, and each viscoelasticity parameter had a joint control strategy that best produced model robustness.

This suggests that there are unique optimal joint control strategies for postural robustness because passive joint properties may change due to factors such as aging and training.

### **INNOVATIVE VIDEO FEEDBACK ON JUMP-LANDING STRATEGIES IMPROVES LANDING TECHNIQUE IN MALE TEAM SPORT ATHLETES**

Dallinga, J.M.1, Benjaminse, A.1,2, Gokeler, A.1, Cortes, N.3, Otten, E.1, Lemmink, K.A.P.M.1,2

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**Introduction** The use of instructions or feedback has been shown to assist in learning movement patterns, such as jump and landing technique (Makaruk et al., 2012; Wulf and Dufek, 2009). Feedback with an external focus of attention, for instance video feedback, stimulates automatic learning processes and may be beneficial in learning these tasks (Benjaminse and Otten, 2011). The purpose of this study was to evaluate the effect of video feedback on drop vertical jump (DVJ) landing strategies in team sport athletes. **Methods** Forty male and forty female athletes were randomly assigned to the video feedback (VI) or control (CTRL) group. Pretest (5 DVJ's), 2 training sessions (TR1 and TR2) including 15 DVJ's and a posttest (5 DVJ's) were conducted. In TR1 and TR2, video feedback by means of an expert overlay movement of the athlete was provided to the VI group, while the CTRL group did not receive feedback. To determine differences between time, groups and sex, repeated measures ANOVAs were conducted. Outcome variables were 3D kinematics and kinetics during pre- and posttest and percentage overlap of expert and athlete performance during TR1 and TR2. **Results** At posttest, males in the VI group showed greater hip flexion angles ( $p=0.001$ ) and greater range of motion, smaller vertical ground reaction force (vGRF) and smaller ankle dorsiflexion moment ( $p<0.001$ ) compared to pretest. At posttest, males in the VI group demonstrated smaller vGRF ( $p=0.031$ ) and smaller ankle dorsiflexion moment ( $p=0.001$ ) compared to the males in the CTRL group. The VI group increased percentage overlap during TR1 ( $p<0.001$ ,  $ES=3.32$ ), TR2 ( $p<0.001$ ,  $ES=2.48$ ) and from start of TR1 to end of TR2 ( $p<0.001$ ,  $ES=3.33$ ). **Conclusion** Video feedback with overlay method changed DVJ landing strategy favorably in males and can therefore be recommended for use in practice. This implies less time investment from medical and training staff and the athlete can pay more attention to the constantly changing environment. Although females were able to imitate the expert model, their landing biomechanics did not change significantly. Potentially females need additional verbal feedback. Further research is necessary to evaluate the effect of a combination of video and verbal feedback on jump-landing patterns in females. How the results of this study relate to ACL injury risk is topic for future studies. **References** Benjaminse A, Otten E. (2011). *Knee Surg Sports Traumatol Arthrosc*, 19(4):622-7. Makaruk Porter J, Czaplicki A, Sadowski J, Sacewicz T. (2012). *J Sports Med Phys Fitness*, 52(3):319-27 Wulf G, Dufek JS. (2009). *J Mot Behav*, 41(5):401-9 Contact: j.m.dallinga@umcg.nl

### **CLASSIFICATION OF ICE HOCKEY SKILL LEVEL BASED ON PRINCIPAL MUSCLE RECRUITMENT STRATEGIES**

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**Introduction** Ice hockey is characterized by explosive movement patterns, where players able to increase their speed at greater rates than their rivals can gain substantial performance advantages. Principal component analysis (PCA) and support vector machines (SVM) are pattern recognition methods that enable identification of movement features, and classification of skill levels (Eskofier et al., 2011). The purpose of this study was to (1) characterise principal muscle activation patterns during accelerative hockey skating, and (2) classify players' skill level based on these principal patterns. **Methods** EMG was recorded at vastus medialis (VM), vastus lateralis (VL), gluteus medius (GM), tibialis anterior (TA) and medial gastrocnemius (MG) during 30m maximum effort skating in nine elite and nine recreational hockey players. EMGs were wavelet transformed to obtain signal intensity across time and frequency space. The 2nd (acceleration) stride was extracted and muscle coordination patterns were analysed with PCA. PC scores for each group were obtained by projecting the original data onto each PC vector, and subsequently entered into a linear SVM to classify skill level. **Results** The dominant muscle activation strategy was the sequential activation of the hip and knee extensor muscles; GM, VM and VL. This was followed by contributions from MG and VM with an inverse contribution from VL. SVM classified 83% of acceleration strides correctly according to skill level ( $p<0.05$ ). Expressing PC scores in the original coordinate space revealed hip-knee extensor activity to be the dominant strategy in elite hockey skating, whereas recreational players showed greater reliance on ankle plantar flexor activity. **Discussion** Hip abductor activation, combined with rapid recruitment of the knee extensors was the primary muscle activation strategy during accelerative skating. This reflects a characteristic strategy for power production, starting with a low centre of mass, and rapidly abducting the hip and extending the knee to achieve propulsion of the centre of mass. Inverse activation of VM and VL was a secondary feature of muscle co-ordination, providing the knee with greater mechanical stability to counteract the large applied loads during explosive acceleration strides. This study saw significant classification of ice hockey skill levels based on the above principal patterns of muscle activity. Classification and functional interpretation of muscle coordination is important for athletes and coaches to understand the differences in muscle recruitment strategies across skill levels, and monitor changes that result from training. **Reference** Eskofier BM, Federolf P, Kugler, PF, Nigg BM (2011). *Comput Methods Biomech Biomed Engin*, 1-8. Contact ebuckeri@ucalgary.ca

## **Oral presentations**

### **OP-PM36 Sports Medicine & Technology**

#### **MEASUREMENT OF VERTICAL JUMP HEIGHT WITH AN ON-SHOE 3D ACCELEROMETER SENSOR IN DIFFERENT TYPES OF ATHLETES**

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1: NMRC, University of Jyväskylä (Finland), 2: Polar Electro Oy (Finland)

**Introduction** Athletes have an interest for vertical jump height and a jump test is often used as an indicator of lower body performance and explosive strength (Bosco et al., 1983). Different sensors have been used widely in sports testing over the past years and practical solutions would be useful for coaching. The purpose of this study was to investigate the validity of an on-shoe 3D accelerometer sensor in jump height evaluation in athletes' own sport. **Methods** Athletes from cycling, orienteering and basketball were studied to examine the suitability of the on-shoe 3D sensor method for different types of athletes. Subjects ( $n=29$ ) performed three squat jump (SQJ) and three

countermovement jump (CMJ) tests twice. Jump heights were assessed with a Stride Sensor Bluetooth® Smart (Polar Electro Oy, Kempele, Finland) attached to a shoe when jumping on a force plate (FP). A FP flight time method was used as reference for jump height and a FP take of velocity method was used for comparing the maximum jump results (Linthorne, 2001). Results The paired correlation between the 3D sensor and the FP flight time method was 0.97-0.99 ( $p < 0.001$ ). Jump height for SQJ ( $n=174$ ) with the sensor was  $30.4 \pm 5.6$  cm and with the FP method  $29.1 \pm 5.2$  cm. In CMJ ( $n=167$ ) the corresponding values were  $33.5 \pm 6.3$  cm and  $32.1 \pm 5.9$  cm with the sensor and FP, respectively. Single measurements showed high consistency ( $p < 0.001$ ) also with SQJ ICC: 0.95, 95% CI: 0.50-0.98 and with CMJ ICC: 0.95, 95% CI: 0.51-0.98. The correlation of the maximum jumps between the 3D sensor and the FP take of velocity methods was 0.88 ( $p < 0.001$ ). The maximum jump heights with sensor method for the basketball players was  $37.1 \pm 6.1$  cm, which was significantly higher ( $p < 0.001$ ) than the orienteers  $32.0 \pm 4.9$  cm and mountain bikers  $30.3 \pm 5.7$  cm. Discussion The 3D sensor and the FP methods correlated highly significantly in the evaluation of SQJ and CMJ height results of three different types of athletes. However, there was a small but systematic difference in jump height between the methods. The SQJ showed slightly better correlation and less variability with smaller bias of height results than CMJ. The correlation of the 3D sensor method was better with FP flight time than with take of velocity method. These results indicate that a 3D accelerometer sensor implemented on-shoe can be used for jump height evaluation and for maximum jump test. The 3D sensor method would likely offer a practical solution for jump height follow up in coaching. References Bosco, C., Luhtanen, P. & Komi, P. V. 1983. *Eur J Appl Physiol Occup Physiol* 50 (2), 273. Linthorne, N. P. 2001. *Am J Phys* 69 (11), 1198-1204. Contact jar-mo.t.paakkonen@student.jyu.fi

### USING 3D MOTION CAPTURE TO ANALYZE ICE-HOCKEY SHOOTING TECHNIQUE ON ICE

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Introduction: Numerous studies have investigated shooting and skating technique in ice hockey. Studies performed on ice (Goktepe et al. 2010, *Sci Res Essays*) mostly have used high speed cameras to capture kinematic data while studies using 3D motion capture systems have been executed off ice by simulating real ice condition by using e.g. synthetic ice (Worobets et al. 2006, *Sport Eng*, Michaud-Paquette et al. 2011, *Sport Biomech*). Upjohn et al. (2008, *Sport Biomech*) stated that passive marker systems for motion capture have limited applications for collecting data in a field setting. Hence, the aims of the current study are to use a passive marker motion capture system to collect data of professional ice hockey players on ice in order to compare shooting techniques. Method: Two professional ice hockey players from EHC Red Bull Munich, in the top division in Germany, were recruited for the study. Both players used their own skates, gloves, helmets and sticks and wore tight fitting compression clothes. 56 reflective markers were placed on each player, including the stick, to facilitate full body analysis. Markers were also placed on the pucks for velocity measurements. Each player performed 10 slap shots and 10 on-timers, where the puck is hit directly from a pass and often used in power play. Data was collected by 20 Qualisys Uqus 7+ cameras (Qualisys AB, Gothenburg, Sweden) at 240 Hz, within a volume of  $60 \times 15 \times 2$  m. Results: Mean puck velocity for slap shots was  $36.9 \pm 1.0$  m/s for player one and  $36.0 \pm 0.9$  for player two. Larger differences were observed for the one-timers where player one had an average puck velocity of  $39.3 \pm 2.5$  m/s versus  $35.4 \pm 1.0$  for player two. The total mean puck velocity was higher for one-timers compared to slap shots ( $37.3 \pm 2.8$  vs.  $36.4 \pm 1.0$  m/s). Although one-timers had both a higher peak and mean puck acceleration than the slap shoots it was at the same time performed with a much less repeatability indicated by a larger CV for both players (34 and 14 % vs. 7 and 9 %) Discussion: In contrast to previous studies full body 3D data were successfully acquired from ice hockey players on ice by using passive markers and 20 infrared cameras. The system performed well for on ice measurements but the setup time of approximately 15 h should be taken in consideration for future studies. The collected data enables numerous possibilities to investigate different movements where puck velocity only is the first basic analysis performed with the data from the current study. Motion capture technology enables accurate 3D kinematic analysis and in the present study there were clear differences between highly skilled subjects in regard to performance and technique.

### AN ADAPTIVE, REAL-TIME STRIDE DETECTION METHOD FOR SMARTPHONES WITH UNCONSTRAINED PLACEMENT

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Introduction Smartphone accelerometers can be used for estimating frequency of cyclic movements. Estimation of the fundamental frequency provides basis for physical activity assessment and movement recognition and analysis. Previous studies developed methods for frequency estimates, resulting in reasonable to good results during walking and running. However, test protocols were often overly simplified; limited to a few conditions (e.g. walking only) and over small speed ranges. In addition, most often methods were designed to operate for specific sensor locations or required a priori knowledge (calibration, thresholds) in order to work. Smartphones sensors can be used to provide real-time feedback. However, one cannot assume a fixed smartphone location and orientation. In addition, acceleration patterns from left and right steps can differ greatly depending on sensor location. To overcome these limitations, we aimed to detect complete cycles, i.e. strides, in walking and running. Here, we describe a real-time method for stride detection from tri-axial accelerations of unconstrained smartphones. Methods 22 volunteers completed 12 courses (140, 200m) with walking, running, sprinting and related activities such as: stair climbing, turning, slalom, small steps and answering the phone. True Positives (TP) and False Positives (FP) were found by comparison with a second method, based on foot sensors (golden standard). The stride detection method was evaluated for 10 different sensor placements, on the trunk and limbs, among which three were smartphones (hip, arm, trouser pocket). The local ethics committee approved the study and subjects signed informed consent. Results For the smartphone placements in walking, running and sprinting, TP ranged from 93 to 100% and FP from 8 to 27%. For the remaining seven sensors, we obtained TP from 90 to 100% and FP from 4 to 30%. Including all activities and sensor locations tested, we obtained TP from 84% to 100% and FP from 5 to 48%. Discussion In this study, we included multiple walking and running related events to simulate free-living conditions. To simulate the unconstrained smartphone placement, a variety of sensor placements was used. Even with those challenges, our on-line algorithm provided accurate feedback about stride frequency. Conclusion The novel algorithm provides accurate feedback on stride frequency in walking and running related events, independent of smartphone (sensor) location/fixation on the body. These results encourage exploring the possibilities of generalizing usage of the method for other repetitive activities, such as rowing, swimming, cycling and skating. Contact B.t.van.oeveren@vu.nl

### A NOVEL METHOD TO ANALYSE INTER-TEAM COORDINATION IN SOCCER USING BIRD'S EYE VIEW VIDEO FOOTAGE

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**Introduction** The study of interpersonal coordination patterns in soccer is nowadays a trendy research topic. Previous investigations identified the importance to evaluate the number of players from each team in the different sub-areas of play as a means to capture teams' performance profiles (Vilar et al., 2013). However, there is a need to develop practical tools to quantify players' positional data from video footage, which may enhance the usability and generalization of these objective methods. Therefore, the aim of this study is to present a novel method to analyse inter-team coordination patterns in soccer from video footage. **Method** The video footage used for this procedure was obtained through a common video camera positioned on the top of a stadium, behind one of the goals. Placing the camera in this position enabled the observers to have a bird's eye view of the entire pitch, including all players involved in the match. From the location of all outfield players in each time frame, the Effective Play-Space (EP-S) is calculated through the utilization of a Matlab® convex hull computation. For this, 19 control points corresponding to some of the pitch line markings were employed to calibrate the system and obtain accurate positional data, using the 'makeform' Matlab® function. The observation procedure implies select four control points in each time frame to determine all players' positions in the field at a given instant. The EP-S was divided into seven sub-areas of play (% of the total EP-S area): Right Defensive (12.5%), Central Defensive (12.5%), Left Defensive (12.5%), Central Area (25%), Right Offensive (12.5%), Central Offensive (12.5%) and Left Offensive (12.5%). The analysis considers the distribution of players in this dynamically adaptive area of play, changing from frame to frame during the match (Vilar et al., 2013). The script generates, through a spatial transformation, a 2D reconstruction of the players' pitch coordinates, the EP-S area and the location of the players within the seven sub-areas of play. As so, we obtain automatically: i) the number of players from each team inside the different sub-areas of play in each time frame, ii) the difference between the number of players from both teams, iii) the net team numerical advantage (disadvantage in case of negative values), and; iv) the uncertainty of each team numerical advantage in each sub-area of play. This latter measure is calculated through the utilization of Shannon's entropy, H (Shannon, 1948). The mentioned outcome measures are generated by frequency and entropy histograms for different game periods the user may define. All computations are performed through Matlab® 2012b. **References** Shannon CE. (1948). *Bell Syst Tech J*, 27(1), 379-423, 623-656. Vilar L, Araújo D, Davids K, Bar-Yam Y. (2013). *J Syst Sci Complex*, 26(1), 73-84. Contact mirandamonteiro@globo.com

### AUTOMATIC DETERMINATION OF BIOMECHANICALLY RELEVANT EVENTS IN FIGURE SKATING SINGLE JUMPS WITH UNIAXIAL ACCELERATION DATA

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*Universität Stuttgart*

**Introduction** To improve technique in sports, precise capturing of biomechanically relevant events is essential. In figure skating, it is challenging to identify events like toe-pick (E1), release of glide leg (E2), take-off (E3) and landing (E4) in single jumps. Video-based procedures are used for this purpose as state of the art (Albert & Miller, 1996; King, Smith, Higginson, Muncasy, & Scheirman, 2004). However, accuracy and usability of these procedures are limited. Therefore the purpose of this study is to develop and validate a software algorithm to determine biomechanically relevant events in single jumps by uniaxial acceleration data. **Methods** Data sets of over 400 figure skating jumps in the six jumping techniques are available from previous research. Data sets contain uniaxial acceleration signals from both feet and time values of E1-E4 and were considered as reference. E1-E4 were defined by an experienced observer with respect to characteristic acceleration signals, validated by synchronised high speed video sequences. Different software algorithms were developed in Matlab to determine time values of E1.c-E4.c based on the input of uniaxial acceleration data. Computed time values of E1.c-E4.c are tested for agreement with E1-E4 (reference) by Bland-Altman-Plots (Bland & Altman, 1999). Accepted limits of agreement (LoA) are set to +/-2ms by practical considerations of reliable diagnostics in figure skating jumps. Results Bland-Altman-Plots were computed for all jump techniques and all events (E1-E4). Algorithms were optimized to get all jump techniques to systematic LoA < +/-2ms. Algorithms show already high reliability for E4, E1 (LoA -1,2ms; 1,9ms) and good reliability for E3 (LoA -3,4ms; 2,7ms). Further results will be presented at the conference (work in progress). **Discussion** Validity of reference time values E1-E4 in available data sets was already shown in our previous research. Automatic, objective and reliable determination of biomechanically relevant events in figure skating jumps by software algorithms enable objective live feedback about flight time and contact time during the training process on ice, which is beneficial in long term performance improvements by efficient training. **References** Albert, W. J., & Miller, D. I. (1996). Takeoff characteristics of single and double axel figure skating jumps. *Journal Of Applied Biomechanics*, 12(1), 72-87. Bland, J. M., & Altman, D. G. (1999). Measuring agreement in method comparison studies. *Statistical Methods in Medical Research*, 8, 135-160. King, D. L., Smith, S., Higginson, B., Muncasy, B., & Scheirman, G. (2004). Characteristics of Triple and Quadruple Toe-Loops Performed during The Salt Lake City 2002 Winter Olympics. *Sports Biomechanics*, 3(1), 109-123. Contact karsten.schaefer@inspo.uni-stuttgart.de

### PREDICTION OF THE SOCCER BALL TRAJECTORY BY ITS PANEL SHAPES

Hong, S., Asai, T.

*University of Tsukuba*

**Prediction of the soccer ball trajectory by its panel shapes** **Introduction** Soccer ball panels have evolved significantly beyond the conventional in terms of their shape and design. However, there has been no study on the flow of air around soccer balls with respect to the shape, number, and orientation of their panels. Therefore, in this present study, we clarified how the panel characteristics affect the flight of a soccer ball, which enables the prediction of the trajectory. **Methods** We used wind tunnel tests and a kick-robot to examine the relationship between the panel shape and orientation of soccer balls and their aerodynamic and flight characteristics. Also, the air flow on the surface of the ball was examined using a PIV (Particle Image Velocimetry). Micro-droplet particles with diameters of 1µm were generated by an aerosol generator, and were introduced into the flow from the sirocco fan in the wind tunnel. A high repetition-rate pulsed ND:Yag laser illuminated the microdroplet particles. A high-speed camera was used to record tiff images at a sampling frequency of 1000Hz. Furthermore, we tested PIV using a cylinder to confirm the effect of the panel shapes. **Results** The position of the separation points differed according to the position of the seams and their number in the sagittal plane of the soccer ball. First, in the case when there were 2 seams with a spacing of about 80mm between them, the separation point was in a position of about 120°. In the panel type with 3 seams on the surface of the ball and the spacing between the successive seams was about 45mm, the airflow around the soccer ball re-attached in seam2 and seam3, and the separation point was about 145° having moved to the rearmost position. Further-

more, the lift force was measured while rotating the single-seam cylinder from 0° to 150°. The largest force (-14.1 N) was observed when the position of the seam was at 75°. Thus, the PIV measurements showed that the boundary separation varies depending on its orientation. Therefore, the positions of the seams on the surface of a soccer ball are considered to have a significant impact on the aerodynamic characteristics and flight trajectory. Discussion The change in the air flow on the surface of the ball, caused by the shape of the panel, has an impact on the aerodynamic characteristics and flight trajectory of the ball, which supports the findings from previous studies (Goff et al., 2014; Hong and Asai, 2014). It is believed that from these results the aerodynamic characteristics and flight trajectory of a ball could be predicted based on the shapes of the panels. Furthermore, the observed effect of the surface shapes (numbers and orientations of the panels) on the flight characteristics is beneficial for practical soccer coaching and the design of new soccer balls. References Goff E, Asai T, Hong S. (2014) *J Sports Eng and Tech*, 228, 188-194. Hong S, Asai T. (2014) *Sci. Rep.* 4, 5068.

## Oral presentations

### OP-PM35 Sport Technology: Mixed session

#### COMPARISON OF THE RELIABILITY OF TWO ELECTRONIC CHEST PROTECTOR AND SCORING SYSTEMS IN OLYMPIC TAEKWONDO

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**Introduction** In Taekwondo, the most frequent area to score points is on the chest protector (O'Sullivan et al., 2009). As taekwondo kicking is very fast and competitions have had issues with the unfairness of judging in sparring competition (Chi et al., 2004; Moon, 2003), the electronic protector and scoring system was introduced in 2010 (Ko et al, 2011). The aim of this study was to investigate the reliability of the electronic chest protector and scoring system using a mechanical system. **Methods** Two World Taekwondo Federation (WTF) recognized electronic chest gear size 1 and size 4 (same company) were selected for testing. Each of the chest gears were hung upside down and secured to a 30kg sandbag. An aluminium tube striker (weight 4.5 kg; length 500mm; diameter 80mm) mounted to a ball bearing pivot point rotating about a solid aluminium pipe which was connected to a drop weight of 100kg. Each of the electronic chest protectors were subjected to 60 impacts by the striker at various velocities, between 4.1 m/s and 8.5 m/s, which was verified by a photoelectric light sensor (Autonics, USA). The outputted variables were the striker's velocity just before impact and the electronic chest protector and scoring system score. Results The striker's velocities ranged from 4.14 to 8.42 m/s, while the electronic chest protector and scoring system registered scores from 11 to 52 (units are unknown). The Pearson's correlation coefficient R2 for the chest gear size 1 was 0.41 and for the size 4 was 0.31. **Discussion** The results show a weak (0.3 – 0.39) to moderate positive (0.4-0.69) relationship for the electronic chest protector and scoring system (Dancey and Reidy, 2004). These low correlations indicate that the scoring system may not be reliable between measurements and maybe a cause of concern when used in competition. With the expense of the electronic chest protector and scoring systems our research was limited to the data collection for only two chest protector's size 1 and 4. Future research should investigate the reliability of all the different sizes of electronic chest protectors for the companies that are currently WTF recognized. References Chi EH, Song J, Corbin G. (2004). Proceedings of the 17th annual ACM symposium on User interface software and technology, ACM, New York, USA., 277-285. Dancey C, Reidy J. (2004). *Statistics Without Maths for Psychology: Using SPSS for Windows*. London: Prentice Hall Ko, YJ, Cattani, K., Chang, Y. Hur, Y. (2011). *Int. J. Sport Management and Marketing*, Vol. 9(3/4), 238-253. Moon WJ. (2003) *Int J Appl Sport Sci* 2003;15(2):85-94. O'Sullivan D, Chung CS, Lee KK, Kim EH., Kang SC, Kim TH, Shin IS. (2009) *JSSM* 8 (CSSI III), 13.16. Contact [davidosullivan@pusan.ac.kr]

#### DIFFERENCES IN MOTIVES FOR RUNNING AND PERCEIVED IMPORTANCE OF APP FUNCTIONALITIES BETWEEN FAST AND SLOW RUNNERS

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*University of Applied Science Amsterdam (Amsterdam, The Netherlands), Inholland University of Applied Sciences (Haarlem, The Netherlands), UMCG.RUG (Groningen, The Netherlands)*

**Differences in motives for running and perceived importance of app functionalities between fast and slow runners** **Introduction** Use of mobile applications (apps) is emerging in individual sports and may have the potential to stimulate physically activity (Stephens and Allan, 2013; Glyn et al., 2014). The question is which motives and app functionalities are important for less trained athletes to engage in running. The purpose was to examine differences in motives for running and perceived importance of app functionalities between fast and slow runners. **Methods** A random selection of 15,000 runners (of 54,000 participants) of a 4 and 10 EM recreational run (Dam tot Damloop) in the Netherlands was invited to participate in an online survey two days after the run. The following issues were addressed: age, gender, experience with running, time to complete distance, motives for running and importance of app functionalities. Based on their performance, runners were divided into four groups. For males and females, the fastest and slowest group were compared by using Mann-Whitney tests. Results There were 4307 respondents (28%), of which 1341 were 4 EM runners. Compared to fastest runners, the slowest males (n=32) and females (n=195) were older (45.49±11.96 y and 37.88±10.50 y respectively), more often overweight (BMI>25) (68.8% and 69.9% respectively) and performed sports less often (88.27±56.63 n/year and 85.88±58.78 n/year respectively). For slower males, losing weight was a more important motive, while for faster male runners competition was more important (p<0.05). For slower females, losing weight and status were more important reasons (p<0.05). Competition, improving own performance, relaxation and being outside were more important reasons for faster female runners (p<0.05). Faster males found monitoring speed, heart rate, progression and personal records more important functionalities (p<0.05). Also, monitoring speed was more important for faster females (p=0.005). Slower females valued training suggestions more as well as following a training schedule, suggestions for running technique, suggestions for development of training and stimulus to hold on (p<0.05). **Conclusion** Losing weight was a more important reason to participate in running for slowest runners. Additionally, slower females valued functionalities that provide information about how to train and thought a stimulus to complete a training was more important. These results can be used to develop an app for stimulating physical activity in inactive individuals. References Glynn LG, Hayes PS, Casey M, et al. (2014). *Br J Gen Pract*, 64(624):e384-91. Stephens J, Allen J. (2013). *J Cardiovasc Nurs*, 28(4):320-9. Contact: marije.baartdelafailledeutekom@inholland.nl



### INFLAMMATION RESPONSE, HEPATIC AND PANCREATIC FUNCTIONALITY DURING PROLONGED EXERCISE IN A PANCREATIC CANCER PATIENT: A CASE STUDY.

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1: DNMS (Verona, Italy), 2: LCBDLRS (Verona, Italy), 3: SGPDPD (Verona, Italy) 4: DBCU (Catania, Italy)

Introduction: Pancreatic adenocarcinoma (PAC) is relatively uncommon, nevertheless it has been proven to be the most unyielding of adversities (Oberstein et al, 2013). Despite of evidence about physical activity correlated with prevention and improvement of quality of life in cancer patients (Cormie et al, 2014), studies about the inflammatory response during exercise in PAC were not found. This study aimed to understand whether prolonged exercise is featured by a so high intensity to trigger a pro-inflammation response, as well as to worsen pancreatic and hepatic functionality in a pancreatic cancer patient. Methods: A controls-supported case study was performed on a 67-year-old man diagnosed with stage IV pancreatic cancer. He performed a 24-hour non-stop ultra-endurance walking (24NS) just before diagnosis (D) and during chemotherapy (D+C). During 24NS blood samples were collected every 6 hours and analyzed for interleukin-1 $\beta$  (IL-1 $\beta$ ), interleukin-1ra (IL-1ra), interleukin-6 (IL-6), interleukin-8 (IL-8), interleukin-10 (IL-10), tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ), monochemoattractant protein-1 (MCP-1), C-reactive protein (CRP), albumin, alanine aminotransferase (ALT), and pancreatic amylase. The patient was compared with two healthy subjects (CS). Results: No adverse events occurred during 24NS. IL-1 $\beta$  and TNF- $\alpha$  did not change in D and D+C. IL-6, IL-8, MCP-1, and CRP increased in the same way in D, D+C, and CS. IL-10 increased in D, but it did not change in D+C and CS. IL-1ra decreased in D, but increased in D+C and CS. Albumin did not change in D and D+C. ALT and pancreatic amylases did not change in D and D+C, but the former increased meanwhile the latter decreased in CS. Conclusion: Ultra-endurance non-stop walking (24NS) is associated with a change in inflammatory response in a PAC patient undergoing and not undergoing chemotherapy, as well as in healthy subjects. Consequently, we suppose ultra-endurance non-stop events are featured by an overall intensity not so high to trigger a pro-inflammatory response when the subject underwent chemotherapy. In addition, although the pancreatic and hepatic functionality of PAC patient were already compromised by the cancer, prolonged exercise does not have such a high intensity to worsen the situation. References: Oberstein PE, Olive KP. *Therap Adv Gastroenterol* (2013), 6(4):321-3372 Cormie P, Spry N, Jasas K, Johannsson M, Yusoff IF, Newton RU, Galvao A. *Med Sci Sports Exerc* (2014), 46(6):66-670 Contact: anna.pedrinolla@univr.it

### ELIMINATION OF TRIAMCINOLONE IN URINE FOLLOWING ORAL ADMINISTRATION OF TRIAMCINOLONE

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*Yuanpei University of Medical Technology*

Triamcinolone is often used to relieve inflammation and treat arthritis, severe allergies and asthma, but it is classified as a glucocorticoid which is banned in-competition when administered orally, intravenously, intramuscularly or rectally by World Anti-Doping Agency (WADA). The Minimum Required Performance Level (MRPL) for the detection and identification of glucocorticoids is 30 ng/mL. Purpose: The purpose of this study was to investigate the eliminated pattern of triamcinolone after administration of a single dose of triamcinolone by oral route and to resolve whether it would cause a positive result in human urine. Methods: Twelve healthy volunteers participated in this study and received a single 4 mg-dose of triamcinolone orally and urine samples were collected according to fixed time intervals for 24 hours. A liquid chromatography-tandem mass spectrometry (LC-MS/MS) method validated to quantify triamcinolone was applied to analyze the urine samples. Results: The results show that the concentrations of triamcinolone in all urine samples were much higher than 30 ng/mL after taking a single dose of triamcinolone. The peak urinary concentration (C<sub>max</sub>) of triamcinolone was 3211.4  $\pm$  860.3 ng/mL (mean  $\pm$  SD), the time to peak concentration (T<sub>max</sub>) was 1.7  $\pm$  0.9 h, the estimated elimination half-life (t<sub>1/2</sub>) was 4.4  $\pm$  2.8 hr in participants receiving a single 4 mg-dose of triamcinolone orally. About 27.76% (1.11mg) of oral dose was eliminated via urine within 24 hours after ingesting. Conclusion: After an oral administrations, the concentrations of triamcinolone in urine would exceed 30 ng/mL for more than 24 hours. This information could be useful for limiting the misuse of triamcinolone by athletes. We suggest that athletes should be aware when using triamcinolone during a competition period and must acquire approval for therapeutic use exemption prior to using it.

## Oral presentations

### OP-SH05 Psychology (Physical exercise, football performance)

#### VARIATION IN THE ABILITY TO MEET RECOVERY DEMANDS EXPLAINS SUSCEPTIBILITY TO BURNOUT IN ELITE SOCCER COACHES

Bentzen, M., Lemyre, P.N., Kenttä, G.

*Norwegian School of Sport Sciences; The Swedish School of Sport and Health Sciences*

Introduction Elite soccer coaches have inconvenient work hours and have to meet a wide range of demands (Rhind, Scott, & Fletcher, 2013). These coaches are also highly passionate and motivated about their work. Highly motivated coaches working under excessive demands are at risk for burnout when recovery is insufficient (Maslach & Leiter, 2007). The current study aims to assess how goal attainment, financial resources, quality of motivation, and workload-related variables contributes to development of burnout in elite soccer coaches during the course of a competition season. Methods A longitudinal mixed method design was used to investigate the hypotheses. Elite soccer coaches from Norway participated in the study (T1: N = 92; T2: N = 61). First, data was collected with an online survey at the start and the end of the season, assessing the burnout dimensions, perceived goal attainment, perceived workload, work home interference (WHI), recovery, and quality of motivation. Financial resources were objectively measured bases on the budget of the soccer clubs. Additionally, four head coaches were purposefully selected for follow-up interviews based on their scores on exhaustion and cynicism assessed at seasons end. Coaches with the two highest and the two lowest scores were selected. Individual profiles of the interviewed coaches were created based on their quantitative data: High-Burnout Coaches (HBC) or Low-Burnout-Coaches (LBC). Their scores on all study variables were compared to the total sample, and evaluated to be different if they were one standard deviation below or above the mean. Qualitative data was analyzed systematically based on the topics found to differentiate between the HBC and LBC profiles. Results HBC and LBC yielded no difference in regard to financial resources, goal attainment, and perceived workload although as a whole HBC offered more maladaptive motivational profiles when compared to LBC. HBC were higher in WHI and lower in recovery. Discussion From a motivational perspective, HBC were more driven by internal pressure and less by interest and fun. LBC were clearly

motivated by their genuine interest and joy for coaching. A clear difference was found between the burnout profiles when it came to WHI and recovery. HBC clearly experienced higher levels of WHI and expressed difficulties finding effective recovery strategies. The current findings highlight the importance of providing elite soccer coaches with strategies to better meet their recovery demands. References Maslach, C., & Leiter, M. P. (2007). Burnout. *Encyclopedia of stress*, 368-371. Rhind, D. J. A., Scott, M., & Fletcher, D. (2013). Organizational stress in professional soccer coaches. *International Journal of Sport Psychology*, 44(1), 1-16.

### **SPORT PRACTICE, CARDIORESPIRATORY FITNESS AND VIGILANCE IN YOUNG ADULTS: AN EVENT-RELATED BRAIN POTENTIAL STUDY**

Luque-Casado, A.1, Perakakis, P.1, Guerra, P.1, Llorens, F.2, Kao, S.C.3, Hillman, C.H.3, Sanabria, D.1

(1) University of Granada, Spain. (2) Catholic University of Valencia, Spain. (3) University of Illinois at Urbana-Champaign, USA.

Introduction Luque-Casado et al. (2013) found better vigilance performance in young athletes than in non-athletes, indexed by shorter reaction times (RTs) in a 9' version of the Psychomotor Vigilance Task (PVT). This result extended previous research that has shown a positive relationship between sport practice, cardiovascular fitness and cognitive performance to the case of young adults and vigilance. Here, we used event-related potentials (ERPs) to investigate neural mechanisms related to improved vigilance performance in athletes reported in our previous study. Importantly, we used a 60' version of the PVT to investigate the time course of these group differences. Methods Two groups of participants (athletes and non-athletes) completed a 60' version of the PVT. Behavioural and ERP indices were acquired using a 64 channel ActiveTwo Biosemi system. After the experimental session, they performed an incremental exercise test in order to assess their fitness level using a Jaeger Master Screen gas analyzer and a Viasprint150P cycle-ergometer. Results The PVT results showed that athletes responded with shorter RTs than non-athletes, but only in the first part of the task. Crucially, and in keeping with the behavioural results, athletes showed greater contingent negative variation (CNV) than non-athletes mainly at the beginning of the task. Additionally, athletes maintained similar target-related P300 amplitudes throughout the task, while non-athletes showed a linear decrement. Discussion Together with our previous findings (Luque-Casado et al., 2013), these results support a positive relationship between physical exercise and cognitive performance (Hillman et al., 2008). Athletes showed improved RT performance at the beginning of the task, presumably due to their better response preparation as indexed by the larger CNV. The P300 result point to greater attentional vigilance in athletes compared to non-athletes. These results are discussed along the two most widespread hypotheses in the literature (i.e., the "cardiovascular fitness and selective improvement" and the "cognitive component skills"). References Hillman, Erickson & Kramer (2008). Be smart, exercise your heart: exercise effects on brain and cognition. *NatureRevNeur*, 9(1), 58-65. Luque-Casado, Zabala, Morales, Mateo-March & Sanabria (2013). Cognitive Performance and Heart Rate Variability: The Influence of Fitness Level. *PLoS ONE*, 8(2), e56935. Contact antonioluque@ugr.es

### **DISPOSITIONAL MINDFULNESS AND INHIBITORY FUNCTION AMONG ELITE MALE SOCCER PLAYERS.**

Meland, A., Kazuma, I., Høgmø, P.M., Pensgaard, A.M.

*Norwegian School of Sport Sciences*

Soccer is characterized by continuous and unpredictable change. Players are required the ability to control attention for quality observation and decision-making in ever-changing situations. The level of intrapersonal mindfulness is suggested to be a performance enhancing factor in demanding situations (Meland et al., 2015), and different facets of mindfulness have been found to be associated with either perceptual attunement or executive control mechanisms (Annicha et al., 2012). However, to our knowledge, little is known about the association between inhibitory control functions and mindfulness in high performance cohorts. Therefore, we tested 42 elite soccer players on the Sustained Attention to Response Task (SART; Robertson et al., 1997), and the Attentional Capture Task (AC; Theeuwes & Chen, 2005), and a multidimensional self-report mindfulness questionnaire (FFMQ; Baer et al., 2006). Our main findings were that players high on the observe factor of mindfulness made fewer errors on the SART and demonstrated more efficient use of relevant stimuli on the target location on the AC test. For the non-judgemental factor of mindfulness we found an opposite trend. Higher scores on the non-judgemental factor were associated with more errors on the SART and less use of relevant stimuli on the target location on the AC. The underlying mechanisms and applied implications are discussed.

### **THE BURDEN OF EXPERTISE**

Hofseth, E., Toering, T., Jordet, G., Ivarsson, A.

*Norwegian School of Sport Sciences, Halmstad University*

Evolutionary research indicates that underestimating one's capabilities maximizes individual fitness in extremely competitive conditions (Johnson & Fowler, 2011). Further, it has been reported that the top performers tend to underestimate their performance attributes in reference to their peers, which has been labeled as "the burden of expertise" (Dunning, 2005). With respect to athletes' performance, however, the general stand has been that positive self-perceptions about one's capabilities, even if they exceed one's actual capabilities, are adaptive (Bandura, 1997). This study compared youth elite players' and coaches' perceptions of players' skill level, and examined the relationship between this comparison and players' past and future record of playing international matches (N = 338, Mage = 17.8, SD = 1.1). A latent class analysis (Nylund, Asparouhov, & Muthén, 2007) was performed in order to identify subgroups within the population based on the players' and the coaches' ratings of the players' skills. The model with three classes was determined to be optimal (entropy = .76, likelihood ratio test  $p = .02$ ). The classes consisted of 77 (class 1), 90 (class 2), and 100 (class 3) participants. Participants in both class 1 and class 2 indicated higher scores on all skills in comparison to the coaches' scores. The opposite pattern was obtained among the participants in the class 3, where the coaches' scored higher than the participants on all skills. Further, while controlling for age, a multinomial regression analysis ( $X^2(6, N = 266) = 49.39, p < .01$ ) revealed that in comparison to the participants in class 3, both the participants in class 1 (OR = 0.66,  $p < .05$ , 95% CI = 0.46, 0.95) and the participants in class 2 (OR = 0.82,  $p < .05$ , 95% CI = 0.71, 0.91) had a reduced likelihood of playing international matches the next two years. Thus, the "burden" of expertise seems to be a phenomenon in youth elite soccer, predicting a high future performance level. Unrealistically positive self-perceptions concerning skills should therefore be discouraged. Consequently, coaches should provide players with feedback and experiences that gives them insight into the limitations of their skills. References Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: Freeman. Dunning, D. (2005). *Self-insight: Roadblocks and detours on the path to knowing thyself*. New York, NY: Psychology Press. Johnson, D. D. P., & Fowler, J. H. (2011). The evolution of overconfidence. *Nature*, 477, 317-320. doi:10.1038/nature10384 Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007).

Latent class analysis and growth mixture modeling: A monte carlo simulation study. *Structural Equation Modeling*, 14, 535-569. Contact: erik.hofseth@nih.no

### **MOTRICITY LEVEL AS AN EXPRESSION OF PRACTICING PHYSICAL EXERCISES- ARGUMENT IN PSYCHOSOCIAL ADJUSTMENT OF ADOLESCENTS**

Mosoj, A., Balint, L.

*Transilvania University of Brasov*

**Introduction:** Physical exercise as an expression of conscious motricity, oriented towards well-defined goals, can be shaped in the most natural form of an individual's adaptation to new realities of society, especially at the adolescence age, at which young people possess very few tools to support decently the expected social behavior. Our research aims to identify valences which controlled motricity may affect adolescents with integration issues - subjects with conduct problems and subjects with disabilities - by linking their level of psychomotor (investigated some of its components) with their psychosocial attitude and behavior, which they manifest and/or self-evaluate. **Methodology:** Our preliminary study was conducted on a sample of 40 students, with an average age of 14,2 and standard deviation of 1.09, divided into four groups: group 1, adolescents who practice sports every day, group 2, teenagers who do not practice sport, group 3, adolescents with conduct problems (psychiatric clinical cases) and group 4, adolescents with psychomotor disabilities. Each adolescent/group membership was involved in a test protocol, which included two ways of investigation: psychological (personality test EPQ Junior, test motivation PM – Teresa Amabile, self-perception test) and motor test (test of 15 seconds – Opto Jump). **Results:** The ANOVA procedure gave following results: teenagers with conduct disorders and adolescents that practice sports,  $F = 3.29$ ,  $df_3$ ,  $p = .033$ . There were no differences at motivational level. But there were differences in self-perception among students who do not practice sports and those who practice sports,  $F = 3.05$ ,  $df_3$ ,  $p = .043$  and differences at motor level between all four groups,  $F = 25.17$ ,  $df_3$ ,  $p = .000$ . **Discussion:** Motor development of individuals is varying by the level of daily practice of sport activities in an organized way in certain directions (Richardson et al. 2005). Very important to note is to provide information to adolescents about the dangers of not practicing sports daily (Trudeau et. Shepard, 2009). Comparing the level of physical and psychical development between these groups might help teenagers to develop education through physical exercises and among adolescents with conduct problems (Maian et al.2007) and even among those with psychomotor disabilities. **ACKNOWLEDGEMENT:** This paper is supported by the Sectoral Operational Programme Human Resources Development (SOP HRD), financed from the European Social Fund and by the Romanian Government under the Project number POSDRU / 159 / 1.5 / S / 134378 and we hereby acknowledge the structural funds project PRO-DD (POS-CCE, O.2.2.1., ID 123, SMIS 2637, ctr. No 11/2009) for providing the infrastructure used in this work. **Literature:** Maian, C., Ninot, G., Morin, A.J.S., Bilard, J (2007). ADAPTED PHYSICAL ACTIVITY QUARTERLY, 24, 178-196 Human Kinetics, Inc. Richardson, C. R., Faulkner, G., McDevit, J., Skrinar, G. S., Hutchinson, D. S., Piette, J. D. (2005) PSYCHIATRIC SERVICES.Vol. 56 No. 3. Email:alex2mos@yahoo.com

## **Oral presentations**

### **OP-SH01 Sports Pedagogy and History**

#### **CHILDREN AND PARENTS' PERSPECTIVES ON INCLUSIVE PHYSICAL EDUCATION: PROBLEMATIZING SELF-DETERMINATION AND SHARED RESPONSIBILITY**

Wilhelmsen, T., Sørensen, M.

*Norwegian School of Sport Sciences*

**Introduction** Inclusion of children with disabilities in physical education (PE) as repeatedly been examined. However, majority of studies has focused on pre- and in-service teachers (Qi & Ha, 2012), while research with children and their parents have been given less attention. Based on research carried out with children with disabilities and their parents, this presentation aims to problematize current practices of inclusive PE in Norwegian elementary schools in terms of self-determination (SD) and shared responsibility. **Methods** In this study we used purposive sampling to recruit families through a governmental habilitation center. Data presented is based on semi-structured interviews and drawings with children and their parents. The data was first coded inductively with descriptive open coding, followed by deductive coding (Miles & Huberman, 1994) informed by SD theory (Deci & Ryan, 2004) and research on home-school collaboration (Bæck, 2007). The following results are based on preliminary analysis of interviews with 11 families: 6 boys, 3 girls in the age range 8-13, and 8 mothers and 4 fathers. End date for data collection is March, 2015. **Results** Preliminary analysis indicated that parents' received very limited information about PE compared to other schools subjects, which affecting their ability to contribute to their child's situation. Environmental factors such as school administrators' and teachers' attitudes, planning and opportunity for self-determined behavior in teacher-child/teacher-parents relationships were emphasized as more important facilitators or barriers for inclusion than children's degree or form of disability. **Discussion** The initial analyses indicate that children and parent's knowledge and experiences were not used to its full potential in terms of planning, preparing and organizing PE. Interestingly, children reported wanting to be self-determined, but at the same time they problematized the balance between autonomy, responsibility and dependency. Both parents' and children's accounts demonstrate the ambiguous and contextual nature of perceived appropriateness of shared responsibility and SD in the planning and implementation processes of PE. **References** Bæck, U. D. K. (2007) Foreldreinvolvering i skolen [Parental involvement in school]. Tromsø: Noruts AS. Deci, E. & Ryan, R. M. (Eds). (2004) Handbook of Self-Determination Research. Rochester, NY: The University of Rochester Press. Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: an expanded sourcebook. Thousand Oaks, Calif.: Sage. Qi, J., & Ha, A. S. (2012). Inclusion in Physical Education: A review of literature. *International Journal of Disability Development and Education*, 59(3), 257-281. doi: 10.1080/1034912X.2012.697737

## SKIING AND SCIENCE – PRACTICE, THEORY AND CO-PRODUCTION OF TRAINING KNOWLEDGE IN CROSS-COUNTRY SKIING SINCE THE 1950S

Svensson, D.

*Royal Institute of Technology KTH*

Introduction Elite endurance athletes of today use specialized, scientific training methods and the increasing role of science in sports is undeniable. This is especially true for cross-country skiing. But how and when did scientists and educated coaches gain power? Scientification of training methods in cross-country skiing accelerated in the 1950s and cross-country skiing was an early adopter, even if not all skiers were (Svensson 2013). Still, the experiential knowledge of skiers remain important. How have these different knowledge traditions merged? How has it changed training in theory and practice? Methods This paper analyzes how physiologists and skiers interacted in the transformation of training methods. Material from archives, interviews and previous research will be studied using theories of bio-power (Foucault 1998), sportification (Yttergren 2006, Guttmann 1978) and STS (Knorr-Cetina 1999, Latour 1987) Skiers from Sweden and Norway are the main examples. Results and discussion Training methods were developed through meetings between practitioners and theoreticians. Scientification of training was driven by hardening international competition. The creation of "rational" training methods was a co-production of knowledge between different knowledge traditions: the traditional, local, tacit knowledge (Polanyi 1958), of skiers and the scientific, written knowledge with universal claims that scientists stood for. The co-production of training knowledge was a matter of control over bodies. Should they be subjected to bio-power (Foucault 1998, 2001) or should they remain under the control of the practitioner? The relationship between skier and scientist resembled that of patient and doctor. Interaction between the expert on the local level (skier /patient) and the universal level (physiologist/doctor) resulted in a knowledge-base that affected both practice and theory. Rational training was in practice not built only on science but also on the individual experience of elite skiers. References Foucault, M.(1998), *The Will to Knowledge. The History of Sexuality, Vol. 1.* New York: Penguin Books Guttmann, A. (1978), *From Ritual to Record. The Nature of Modern Sports.* New York: Columbia University Press Heggie, V. (2011), *A History of British Sport Medicine.* Manchester: Manchester University Press Knorr Cetina, K. (1999), *Epistemic Cultures: How the Sciences Make Knowledge.* London: Harvard University Press Latour, B. (1987), 'Centers of Calculation', in *Science in Action: How to Follow Scientists and Engineers Through Society.* Cambridge, MA: Harvard University Press, pp. 215-257 Polanyi, M. (1958), *Personal Knowledge. Towards a Post-Critical Philosophy.* Chicago: University of Chicago Press Svensson, D.(2013), 'How Much Sport is there in Sport Physiology?' in *The International Journal of the History of Sport*, vol. 30, no. 8, pp. 892-913 Yttergren, L. (1996), *Täflan är lifvet.* Stockholm : Stockholmia

## TALENT DEVELOPMENT AS AN ECOLOGY OF GAMES: A CASE STUDY OF NORWEGIAN HANDBALL

Bjørndal, C.T., Ronglan, L.T.

*Norwegian School of Sports Sciences*

Introduction Structured talent identification and development (TID) is suggested as a key pillar in international sporting success (De Bosscher, De Knop, Van Bottenburg, & Shibli, 2006) and many modern elite sport systems have applied normative TID models (Bailey & Collins, 2013). However, Norwegian handball has been highly successful although representing an alternative approach, characterized by a heterarchical organizational structure with several key actors that function highly autonomous, constituting a complex web of activities that can be better understood as an ecology of games (Long, 1958). The aim of the study was twofold: (a) to describe and discuss how aims and strategies vary across and within key actors directly involved in TID, and to (b) identify the inherent organizational characteristics that influence TID processes. Methods The case study focused on TID processes within the organizational context of Norwegian handball, and included two units of analysis: (i) key actors and their characteristics and (ii) key actor's inter-communication and collaboration. Sources of data included (a) document analysis and (b) interviews with 11 key informants. Informants were strategically selected and represent experienced coaches and professionals from multiple organizational units. The main theoretical concepts were used to develop a focused code-scheme and all interviews was analysed using MAXQDA (v.11.1.5). Results The National Handball Federation (NHF) provide a broad-based model for TID were 23% and 15% of male and woman handball players participate in regional level initiatives from age 13 to 17 years, in addition to their daily practice in community-based volunteer sport clubs and sport schools. Actor's primary objectives vary (e.g. qualifying for tournaments, winning a medal, selecting players to special teams) and talent development is often a secondary consequence of team performance goals rather than the sole purpose of practice. Discussion The joint efforts from multiple actors involved in TID provide a broad range of developmental influences that can be exploited. The organizational context shapes developmental pathways towards elite sports and the broad base of TID initiatives creates multiple access points to the talent pipeline during adolescence. However, because the heterarchical structure involves many actors the unintended consequences is often related to properly managing training and competition loads, supporting the need for well-developed coordination mechanisms and good communication between key actors. References Bailey, R., & Collins, D. (2013). *The Standard Model of Talent Development and Its Discontents.* *Kinesiology Review*, 2(4), 248-259. De Bosscher, V., De Knop, P., Van Bottenburg, M., & Shibli, S. (2006). *A Conceptual Framework for Analysing Sports Policy Factors Leading to International Sporting Success.* *European Sport Management Quarterly*, 6(2), 185-215. Long, N. E. (1958). *The local community as an ecology of games.* *American Journal of Sociology*, 64(3), 251-261. christian.bjorndal@nih.no

## MOVEMENT ASSESSMENT TOOLS: A CRITICAL EXAMINATION

Tidén, A., Redelius, K., Lundvall, S.

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Movement Assessment Tools: A Critical Examination Introduction In contemporary society there are calls to increase young people's physical activity. In the wake of this concern we find a growing interest in studying and assessing children's and adolescents' movement abilities. Consequently, there are a number of tools developed for assessing children's movement abilities. However, many scholars have suggested that ability is far from a neutral concept and the notion of ability is often taken for granted as simply a measureable and observable capacity. The aim with this study is to critically examine assessment tools used for healthy and typically developed children. (Evans, 2004; Hay & Macdonald, 2013; Wright & Burrows, 2006). Methods The examination comprises ten tools from six different countries. In the study we pay special attention to selected movement tasks in the tools and the evaluation methods. The theoretical framework is inspired by Bourdieu's concepts of habitus and capital, (Bourdieu, 1988) which are used as analytical tools. The analysis explores and discusses what kind of movement ability the tools may construct. Results The findings show both a great variation of concepts and evaluation methods and a narrow view of what is regarded as valuable to assess. The assessment tools are strongly related to traditional sports and represent a specific form of physical capital. Rhythm and dance, for example, are never or seldom assessed, neither

movements in a broader perspective as open skills or movement tasks taking place in an outdoor environment. The examined tools and tests assess a limited number of decontextualised movements and produce a narrow view of movement ability. Discussion The study gives an overview of what kind of movements and abilities that is valued and promoted in movement assessment. Evaluation processes often promotes a child who is physically mature and benefits those who have experience of traditional sports. In other words, the assessed 'taste for sport' and the 'embodied physical capital' construct what is considered to be legitimate knowledge in relation to movement culture. Accordingly, the construction of movement ability through assessment tools could affect how children see themselves and their 'ability'. The results raises questions about how the assessments influence children's desire to move or their interest for physical activity in broader perspectives. References Bourdieu, P. (1988). Program for Sociology of Sport. *Sociology of Sport Journal*, 5, 153-161. Evans, J. (2004). Making a difference? Education and 'ability' in physical education. *European Physical Education Review*, 10, 95-108. Hay, P.J., & Macdonald, D. (2013). Evidence for the social construction of ability in physical education. *Sport Education and Society*, 15, 1-18. Wright, J. & Burrows, L. (2006). Re-conceiving ability in physical education: a social analysis. *Sport Education and Society*, 11, 275-291. Contact [anna.tiden@gjh.se](mailto:anna.tiden@gjh.se)

## SOCIETY GAINS FROM DAILY PHYSICAL EDUCATION

Ericsson, I.

*Malmö University*

Society Gains of Daily Physical Education The Commission for a Socially Sustainable Malmö (2013) recommends institutions to strengthen the subject of Physical Education and Health (PEH) to all pupils in Malmö schools and the Bunkeflo intervention could serve as a model. The Bunkeflo Model The Bunkeflo project – a health promoting lifestyle was launched in the south of Malmö. PEH was made a daily compulsory subject for all pupils in two schools. Motor skills observations were conducted school years 1, 2, 3, and 9 according to the Motorisk Utveckling som Grund för Inläring (MUGI) checklist. Pupils in need of extra support were given adapted motor training one hour per week. All teachers in the project were educated in the MUGI model of motor skills observing and training. Statistical analyses after nine years showed that both girls and boys improved in motor skills (balance and coordination) and their learning performance became significantly better, with eight percent more pupils being eligible for upper secondary school in the group with daily PEH (n=129) compared with a control group (n=91) (Ericsson & Karlsson, 2012). Health-economic Analysis of Daily Physical Education Health-economic analyses (Gerdtham, Ghatnekar, & Svensson, 2012) of the Bunkeflo intervention show that daily PEH in all Malmö schools would increase the potential production value by SEK 59 million (Euro approx. 6.4 million) during the 10-year period after compulsory school. The higher levels of physical activity would reduce morbidity costs by SEK 56 million (> Euro 6 million). These values exceed the SEK 16 million (Euro 1.2 million) that costs of staff and premises amount to. An investment per pupil of SEK 4,600 (Euro 500) for all nine compulsory school years would give productivity gains and reduced morbidity costs of SEK 38,000 (Euro 4,130) over the 10 years after leaving school. Conclusion The health-economic evaluation of the project shows that the investment was clearly profitable for the municipality (Gerdtham, Ghatnekar, & Svensson, 2013). References Gerdtham, U., Ghatnekar, O. & Svensson, M. (2012). Hälsoekonomiska utvärderingar. The report accounts for how health-economic analysis methods can be used as the basis for prioritizations when resources are limited. Lund: The Swedish Institute for Health Economics. Gerdtham, U., Ghatnekar, O. & Svensson, M. (2013). Health economics evaluations - basic data for the Commission for a Socially Sustainable Malmö. Malmö: Commission for a Socially Sustainable Malmö. Ericsson I. & Karlsson M. (2012). Motor skills and school performance in children with daily physical education in school - a 9-year intervention study. *Scandinavian Journal of Medicine and Science in Sports*. Available 2012-04-09 on "Wiley Online". The Commission for a Socially Sustainable Malmö (2013). Independent commission appointed by the City of Malmö to suggest objectives and actions to reduce inequities in health. Available 2014-12-15 on [www.malmo.se/kommission](http://www.malmo.se/kommission).

## MOVEMENT ANALYSIS OF PLAYING EXERGAMES IN PE

Meckbach, J., Gibbs, B., Almquist, J., Quennerstedt, M.

*The Swedish School of Sport and Health Sciences*

Introduction Exergames inspire participants to be physically active in order to play. Several scholars pay attention to that the games have become popular among young people and may lead to an attractive alternative for promoting a healthy, active lifestyles, not at least in school (Gao et al 2013, Ennis 2013). In Sweden, PE should offer a variety of movement activities and movement qualities. Interesting to explore is then if exergames can be seen as a teaching resource to learn different movement's qualities? Research question With a new artifact that has been introduced in PE and new policy documents emphasising development of different movement qualities, this paper aims to explore students' movement qualities when they use exergames in PE with support of Laban's movement analysis (LMA) and socio-cultural learning theory. Method The empirical data include video-recordings from three PE lessons. The games offered were of three different characters, and the recorded material for this study includes a total of 24 events of sports games, fitness games and dance games. In the study, we are inspired by the LMA framework and explore students' movement qualities on the basis of four aspects; body, - effort - space and relations. Further, with socio-cultural learning theory, recognition of artifacts, other people and the offered content of the exergames are also involved in the analysis. The learning explored is therefore about aspects where the game, the player and the social environment interact in learning of different movement qualities. Results and discussion Our findings show that exergames are creating opportunities for PE teachers and students to pay attention to different movement qualities. When comparing the three games both similarities and differences in movement qualities emerge in relation to the learning of movement qualities that occurs in the interaction between the game, the learner and the learning environment. In PE the player is accordingly involved in a complex context of movement qualities, interacting with the game and with other student. References Ennis, C. D. (2013). Implications of exergaming for the physical education curriculum in the 21 st century. *Journal of Sport and Health Science*, 2, 152-157 Gao, Z., Hannan P., Xiang, P., Stodden, D. F., Valdez, V. E. (2013). Urban Latino children's physical health and academic performance: effect of active video game based exercise. *American Journal of Preventive Medicine*, 44, 240-246. Contact [jane.meckbach@gjh.se](mailto:jane.meckbach@gjh.se)

**16:45 - 18:00****Plenary sessions****PS-PL01 CHANCES AND CHALLENGES FOR PHYSICAL ACTIVITY AND LEARNING - SUSTAINABLE MOVEMENTS AND MOVEMENT CULTURES**

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**EXERCISE, LEARNING AND MEMORY**

Nielsen, J.

*University of Copenhagen*

It is now firmly established that learning and memory – from learning how to ride a bike to remembering one thousand decimals of pi – rest on physical changes in the synaptic connections of the networks in the nervous system involved in the execution of the relevant functions. The activity-dependency of these plastic changes generally dictates a close relation to prior experience with execution of the specific function by the network. Recent progress in computational and experimental motor neuroscience has resulted in development of fundamental principles of how this learning proceeds in the case of acquisition of new motor skills and how specific changes in synaptic connectivity become consolidated as lasting changes (memory) in network function of the motor areas in the nervous system. Given the established network specificity of learning and memory, it has been surprising that animal experiments have repeatedly documented that exercise may facilitate learning and memory of cognitive as well as motor content (riding a bicycle may facilitate your ability to remember the thousand decimals of pi). Evidence from humans is less convincing, but still supports that exercise performed in close temporal relation to a learning session may facilitate consolidation of the learned material. The exact mechanisms responsible for these effects are still unclear, but neurotrophic factors released from active muscles and the nervous system during exercise are involved. The possibility that muscle metabolites such as lactate and/or activation of monoaminergic pathways in the nervous system play central roles, are presently explored.

**PHYSICAL EDUCATION, EXERCISE SCIENCE AND THE IDEA OF THE OBESITY CRISIS: A MEMETIC CONSIDERATION**

Tinning, R.

*University of Queensland*

The obesity crisis is a major issue that both orients and galvanizes the fields of physical education and exercise science. We can think of the obesity crisis as having a biological dimension, a psychological dimension, and a socio-cultural dimension. This presentation offers a socio-cultural approach to understanding the obesity crisis as an idea. A crisis is a characterization of the perceived severity or urgency of a particular problem, but “problems are not just ‘out there’ like objects of nature; they are socially constructed” (Lawson, 1984). Naming something as a crisis is not simply a benign public reaction to an issue or phenomenon of serious concern. It can be used as a tool for shaping/influencing particular agenda. Importantly, this is not the result of a conspiracy of scientists and politicians, but occurs instead through a complex process of the social production of knowledge. Whatever its multi-factorial causes, the idea of an obesity crisis has certainly “caught on.” But why has it caught on, and why now? In order to investigate this question, I will apply a memetic analysis that is based on the concept of a meme. A meme, a term first coined by evolutionary biologist Richard Dawkins, is claimed to be the cultural equivalent of a gene and a unit of cultural transmission.

# Thursday, June 25th, 2015

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**08:30 - 10:00**

## Oral presentations

### OP-PM63 Nutrition: Fat, glucose and metabolism

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#### **DOES A 15% DIFFERENCE IN CARBOHYDRATE INTAKE AFFECT CYCLING PERFORMANCE AND PHYSIOLOGICAL RESPONSE IN TRAINED ATHLETES?**

El-Chab, A., Simpson, C., Lightowler, H.

*Oxford Brookes University*

**Introduction** Although researchers often inform human subjects to maintain a strict diet before multi-day experiments, the typical subject is likely to vary their carbohydrate intake by 15% or more. We examined the effect of a 15% difference in the carbohydrate intake of trained cyclists on performance, nutrient oxidation during exercise, and blood biomarkers. **Methods** Ten male cyclists completed familiarisation tests and fitness evaluation. On two separate occasions, subjects completed both a prolonged cycle task to exhaustion in order to deplete muscle glycogen (day 1) followed by an endurance capacity test where subjects cycled at 70% VO<sub>2</sub>max until fatigue (day 2). These procedures were replicated in a double blind cross-over design when subjects consumed either a diet containing 4.65 g.kg BM<sup>-1</sup> of carbohydrate (Low) or an energy matched diet containing 5.35 g.kg BM<sup>-1</sup> of carbohydrate (High) between the GD test and TTE test. The two occasions were separated by at least 7-days. Blood glucose and lactate levels were measured at baseline and every 30 min while the respiratory exchange ratio (RER) was measured every 15 min till the end of the TTE test. **Results** Time to completion was not affected by High (88.4 ± 17.7 min) compared to Low (88.6 ± 15.7 min). The High diet also did not have any significant effect on blood lactate and glucose levels, and RER at any time point (except at minute 60 for RER) compared to Low diet. **Conclusion** This study suggests that a variability in carbohydrate intake by up to 15% do not have any effect on cycling performance, nutrient oxidation, blood glucose and lactate levels.

#### **EFFECT OF DIFFERENT SOLUTIONS CONSUMED DURING EXERCISE ON POST-EXERCISE APPETITE**

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The purpose of the present study was to investigate whether the different solutions consumed during moderate intensity exercise will affect the post-exercise ad lib food intake. Totally 12 healthy active male participants (Mean ± SD, Age: 20 ± 1 yr; Height: 176 ± 6 cm; Weight: 63.6 ± 5.3 kg; VO<sub>2</sub>max: 51.2 ± 7.1 ml/kg/min) completed three main experimental trials in a randomized cross-over design. In each main trial, participant completed one hour ergometer cycling at 60% VO<sub>2</sub>max after an overnight fast, followed by 2-hour recovery. During exercise, the participants were required to consume one of three different solutions every 15 min: water (W), carbohydrate-electrolyte solution (CE), carbohydrate-electrolyte-protein solution (CEP). The energy content was matched between the latter two solutions. After recovery period, all participants were provided with an ad lib pizza lunch, and the amount consumed for each participant was recorded. During the experimental trials, subjective appetite scores, blood glucose, body weight, and several other subjective feelings were measured. No differences were found in either pizza amount consumed (W vs. CE vs. CEP: 607 ± 128 vs. 592 ± 119 vs. 599 ± 125 g, p>0.05) or subjective appetite score before pizza consumption (W vs. CE vs. CEP: 14 ± 9 vs. 12 ± 14 vs. 14 ± 10, p>0.05) among three trials. During exercise, the blood glucose concentrations were higher in CE and CEP trials than those in W trial. In conclusion, different solutions consumed during one hour moderate intensity exercise did not affect appetite after two hours' recovery. The present study was supported by Start-up Research Grant (RG 62/2013-2014R) and Internal Research Grant (RG 64/2013-2014R), Hong Kong Institute of Education.

#### **EXOGENOUS AND ENDOGENOUS CARBOHYDRATE OXIDATION FOLLOWING INGESTION OF GLUCOSE AND FRUCTOSE DURING PROLONGED CYCLING: EFFECT OF CARBOHYDRATE DOSE**

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**Introduction** There appears to be a dose dependent curvilinear exercise performance response to ingested carbohydrate (CHO), with an optimum of 78 g/h (Smith et al., 2013). However, the physiological mechanisms underpinning performance gains are unclear and fuel use responses to glucose and mixtures including fructose have not been investigated fully. This study investigated the effect of CHO dose on fuel selection during exercise, in particular exogenous and endogenous (liver and muscle) CHO oxidation. **Methods** Ten trained male cyclists (VO<sub>2</sub>max: 61.6 ± 7.4 ml/kg/min) cycled on 4 occasions at 77% VO<sub>2</sub>max for 2 hours after an overnight fast. From 15 min into exercise and every 15 min thereafter, either 60 g/h glucose (LG), 75 g/h glucose (HG), 90 g/h glucose/fructose (LGF; 2:1 ratio) or 112.5 g/h glucose/fructose (HGF; 2:1 ratio) was ingested in a double-blind randomised order. The formulations contained <sup>13</sup>C tracers and were designed to saturate and over saturate intestinal transporters for each hexose. Total, exogenous, endogenous (muscle and liver) CHO oxidation, and total fat oxidation were computed using indirect calorimetry and isotope ratio mass spectrometry. **Results** Total CHO oxidation was elevated, and total fat oxidation suppressed in HGF relative to all other conditions (CHO 24.9-41.8 g/h higher, Fat 7.9-11.3 g/h lower: both ES > 0.78). Exogenous oxidation was unchanged with higher dose glucose (LG = 41.2, HG = 41.4 g/h, ES = 0.02) and reduced with higher dose glucose/fructose (LGF = 67.7, HGF = 59.2 g/h ES = 0.48). Increasing CHO dose beyond intestinal saturation increased muscle glycogen utilisation for both glucose and glucose/fructose ingestion (125.1±22.6 vs. 109.9±26.9 g/h for glucose, ES=0.59; 129.5±22.6 vs. 100.3±23.1 g/h for glucose/fructose, ES=1.28). Liver glycogen oxidation was reduced with LG vs. HG (20.9±5.6 vs.

24.4±10.1 g/h; ES=0.43), but increased with HGF vs. LGF (30.5±17.7 vs. 19.3±9.4 g/h; ES=0.43). Discussion Increasing CHO ingestion rate for each hexose was not associated with higher exogenous oxidation. When the CHO dose was increased for both glucose and glucose/fructose, endogenous glycogen oxidation was increased, primarily due to an increased reliance on muscle glycogen. This with high liver glycogen and reduced fat oxidation for very high dose glucose/fructose is not ideal for exercise performance. References Smith J, Pascoe D, Passe D, Ruby B, Stewart L, Baker L, Zachwieja J (2013). Curvilinear Dose-Response Relationship of Carbohydrate (0-120g/h) and Performance. *Med Sci Sports Exerc* 45(2): 336-341 Contact A King; a.k.king@leedsbeckett.ac.uk

### THE EFFECTS OF A 5-DAY FASTING PERIOD ON ENDURANCE RELATED PARAMETERS IN HEALTHY ADULTS

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Introduction: Deliberate fasting with restriction to consumption of solid food has a long worldwide tradition. It is conducted for cultural, religious, spiritual or medical reasons. It is known to reduce oxidative damage and inflammation and helps reduce obesity and some chronic diseases (Longo et al., 2014; Varady et al., 2007). However, the effects of fasting on physical performance have mainly been studied for Ramadan intermittent fasting (Chaouachi et al., 2009), whereas the body of evidence regarding effects of other forms of fasting on physical performance is still weak. The purpose of this study was to analyse the effects of a 5-day fasting period following the Buchinger regimen on performance and health related parameters. Methods: 20 healthy normal weight subjects (10 men, 10 women) aged 24.4±6.8 years, baseline BMI 23.6±1.9 kg/m<sup>2</sup>, underwent several medical and physical fitness tests before, during and shortly after the fasting period. Besides analyses of body weight and body composition, subjects performed a ramp treadmill test to determine V<sub>O</sub>2max and RQ at 60% V<sub>O</sub>2max. An incremental step test until exhaustion using the mCAFT protocol was performed (stage duration 5 minutes) to assess performance, heart rates and blood lactate concentrations. Further, a 15-second skipping test was performed to calculate maximum lactate production rate (V<sub>L</sub>max). Statistical analysis included ANOVA and paired t-test, alpha level was set at p<0.05. Results: Body weight decreased by 5.1% (2p<0.001) and body fat percentage decreased by 7.4% (2p<0.001) pre vs. post. Relative V<sub>O</sub>2max increased by 4.7% (2p<0.001) and RQ at 60% V<sub>O</sub>2max decreased from 0.89±0.05 to 0.83±0.07 (2p<0.05) pre vs. post. Time until exhaustion in the step test decreased from 27.8±2.3 min to 26.3±3.1 min (2p<0.05) during fasting, and V<sub>L</sub>max decreased from 0.68±0.15 mmol/l\*s (pre) to 0.57±0.16 mmol/l\*s in this period (2p<0.001). Discussion: After a 5-day Buchinger fasting period, relative V<sub>O</sub>2max increased due to a decline in body weight, and submaximal RQ decreased, indicating a shift in substrate oxidation from glucose towards more fatty acids. During fasting subjects exhausted earlier in the step test, indicating a negative effect of fasting on endurance performance probably due to glycogen depletion. This is in line with the decline in V<sub>L</sub>max. Altogether results indicate effects of fasting on aerobic performance resulting in impairment during and improvement after the fasting period. References Longo V, Mattson M (2014). *Cell Metab*, 19: 181-192. Varady K, Hellerstein M (2007). *Am J Clin Nutr*, 86: 7-13. Chaouachi A et al. (2009). *Int J Sports Physiol Perform*, 4: 419-434. Contact Angi.Eibl@rub.de

### FRUCTOSE-INDUCED HYPERTRIGLYCERIDEMIA DOES NOT ENHANCE POST-EXERCISE RESYNTHESIS OF INTRAMYOCYLLULAR LIPID STORES.

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Introduction Resynthesis of intramyocellular lipid (IMCL) stores after exercise is stimulated by fat feeding. It remains however unknown which of blood non-esterified fatty acids (NEFA) or triglyceride-rich lipoprotein (TRL-TG) concentrations is the main precursor for IMCL. We therefore compared the effects of high fat, high fructose (HFHF) or high fat, high glucose (HFHG) diets on IMCL and glycogen resynthesis after a strenuous, IMCL depleting exercise. Methods Nine endurance-trained males were studied on two occasions in a 2-day experimental protocol. On each occasion, they performed a 2,5-h exercise at 50% of maximal aerobic power to lower their IMCL and glycogen stores on day 1, and their IMCL and glycogen concentrations in muscle vastus medialis were measured by <sup>1</sup>H-MRS 2 hours later (5 pm). Then, and during day 2, they remained at rest in a bed and were fed in randomized order two experimental diets providing 42.6% energy requirements as fat, 17.7% as protein, 5.2% as glucose and 34.8% as either fructose (HFHF) or glucose (HFHG). Net carbohydrate and lipid oxidations were measured by indirect calorimetry, and whole body glycogen synthesis was calculated as total CHO intake – net CHO oxidation. Their muscle IMCL and glycogen stores were measured again at 5 pm. Results On Day 1, IMCL (7.4 ± 1.1 vs 6.5 ± 0.9 mmol/kg ww) and muscle glycogen were similarly depleted on both occasions. On day 2, HFHF diminished average blood glucose and insulin concentrations, increased circulating TG (all p<0.01) but did not alter NEFA levels as compared to HFHG. Net carbohydrate oxidation was 50.8 ± 12.0% higher (p<0.01), and net glycogen synthesis lower with HFHF. At the end of day 2 and compared to day 1, IMCL (+40.4 ± 9.1 vs. +41.1 ± 8.7 %, p=0.96) and glycogen (+31.4 ± 6.8 vs. +38.1 ± 7.4 %, p=0.40) concentrations were significantly (p<0.01) but similarly increased in HFHF and HFHG respectively. Discussion These data indicate that ingestion of fat + fructose increases blood TRL-TG concentration, but not IMCL resynthesis compared to ingestion of fat + glucose. This suggests that IMCL synthesis is not dependent on plasma TG, glucose or insulin, but rather on circulating NEFA concentrations. Muscle glycogen resynthesis was similar with fructose and glucose, but whole body net glycogen synthesis was lower with fructose. This suggests that hepatic glycogen synthesis was lower with fructose. Contact Robin.Rosset@unil.ch

## Oral presentations

### OP-PM06 Training induced adaptation

#### EFFECTS OF AN INSPIRATORY MUSCLE TRAINING VS A CONVENTIONAL EXERCISE THERAPY ON RESPIRATORY FUNCTION AND FUNCTIONAL EXERCISE CAPACITY IN COPD PATIENTS

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Introduction According to GEDDES et al. (2008) it is important in pulmonary rehabilitation to use Inspiratory Muscle Training (IMT) in combination with other interventions. However, there is mostly evidence for the effects of IMT in a longer term outpatient setting, but not in a



hospitalised phase. This study therefore investigated if IMT in combination with conventional exercise therapy can improve respiratory function during a 3 week hospitalisation and if it has positive effects on endurance performance and on HRQL in COPD patients. Methods 44 hospitalised COPD patients (GOLD stages II-IV) were stratified according to their severity stages and allocated to an intervention group (n=21) and a comparison group (n=23). The following test were conducted at baseline and after the 3 week intervention - respiratory function test, 6-Minute-Walk-Test (6MWT), HRQL using the CRQ and a strength test (12-RM). The exercise intervention 3 times a week consisted of strength training, endurance training, breathing therapy and ball games. The intervention group completed additionally an IMT five times a week using the RespiFit S device. Results This study found a significant improvement in respiratory function in the intervention group (IMT) in FEV1. The respiratory strength also increased as expected significantly in the IMT group ( $p < 0.01$ ). Similar results were found in the same group regarding the respiratory strength and respiratory minute volume ( $p < 0.01$ ). The overall cohort of COPD patients showed significant increases in all components of exercise ( $p \leq 0.01$ ) ranging from 11% improved endurance to 25% strength increases. In regards to clinically relevant effects in HRQL the IMT group scored significantly higher in the items mastery and emotional function compared to the comparison group. Discussion Regardless of the effects of IMT, this study confirms the effectiveness of a three week hospitalised rehabilitation programme. It can be concluded that IMT in addition to conventional exercise therapy improves FEV1 as well as inspiratory muscle strength and endurance, functional exercise capacity (6MWT) and HRQL. However, further research is needed to explore the impact that different training protocols may have on outcomes as well as different intervention times during common hospitalisation durations, i.e. 3 weeks vs. 4 vs. 5 weeks. References Geddes EL, et al. (2008): Inspiratory muscle training in adults with chronic obstructive pulmonary disease: An update of a systematic review. *Respir Med*; 102(12): 1715-1729. Contact peter.wright@hsw.tu-chemnitz.de

### COMPARISON OF THE EFFECTS OF TWO SHORT-TERM CARDIAC REHABILITATION PROGRAMS WITH AEROBIC TRAINING ON CARDIAC FITNESS INDICES AFTER CORONARY ARTERY BYPASS SURGERY

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Objective Cardiac rehabilitation after coronary artery bypass surgery (CABG) is one of the well-known and effective methods in increasing physiologic function and functional capacity of patients. In this study, we compared the effects of two short-term (8-session and 24-session) cardiac rehabilitation programs accompanied by aerobic trainings on cardiac fitness indices after CABG. Methods This was a quasi-experimental study. Among the patients who presented to the Research Center of Imam Ali Heart Center in Kermanshah, 24 patients range of 45-74 years old were selected. They were randomly divided into two groups: 12 patients in 8-session group and 12 patients in 24-session group. Before rehabilitation and after echocardiography, the training tolerance test (ETT) was performed and then left ventricular ejection fraction (LVEF), diastolic function, and maximal oxygen consumption ( $VO_2$  max) using the Bruce protocol were calculated and compared between two groups. The data were analyzed by the SPSS software (version 19). Results There was no significant difference between mean LVEF ( $P = 0.8$ ) and diastolic function ( $P = 0.1$ ) before and after rehabilitation in 8-session group. However, a significant difference existed in terms of  $VO_2$  max before and after 8-session rehabilitation ( $P = 0.000$ ). There was also significant differences before and after 24-session cardiac rehabilitation in terms of mean LVEF ( $P = 0.001$ ), diastolic function ( $P = 0.01$ ), and  $VO_2$  max ( $P = 0.000$ ). However, the comparison between two groups showed that there was no significant difference in LVEF ( $p = 0.09$ ), diastolic function ( $p = 0.27$ ), there was significant in  $vo_2$  max ( $p = 0.03$ ). Conclusion The results indicated that as the duration of trainings increases, its beneficial effects will be more prominent. These effects will be more obvious as time passes on both systolic and diastolic functions. Although, 24-session group obviously showed better results in terms of in LVEF and diastolic function, there is only a significant difference in terms of  $VO_2$  max between two groups ( $p = 0.03$ ). email: lahematfar@yahoo.com

### WALKING CAPACITY IS INVERSELY ASSOCIATED TO AMBULATORY BLOOD PRESSURE IN PATIENTS WITH INTERMITTENT CLAUDICATION

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Introduction: Patients with intermittent claudication (IC) present impaired walking capacity and high levels of blood pressure (BP). Ambulatory blood pressure (BP) is known as an important cardiovascular prognostic tool. Nevertheless, to the better of our knowledge, its relationship with walking capacity in patients with IC has not been investigated. Thus, the aim of this study was to assess this relationship. Methods: In 73 patients with IC ( $63 \pm 9$  years), ambulatory BP was recorded for 24 h with measured taken every 15 min, and means of 24-hour, awake and asleep periods were calculated. Claudication onset distance (COD) and total walking distance (TWD) were obtained by a progressive treadmill test (2 mph and increments of 2% every 2 min) conducted to maximal claudication pain. Pearson correlations were calculated. Results: COD was negatively correlated with 24h ( $r = -0.41$ ;  $p < 0.01$ ), awake ( $r = -0.42$ ;  $p = 0.01$ ) and asleep ( $r = -0.37$ ;  $p = 0.01$ ) diastolic BP, while TWD was negatively correlated with 24 h ( $r = -0.23$ ;  $p < 0.05$ ) and asleep ( $r = -0.29$ ;  $p = 0.01$ ) systolic BP, as well as with 24 h ( $r = -0.27$ ;  $p < 0.02$ ), awake ( $r = -0.24$ ;  $p < 0.04$ ) and asleep ( $r = -0.33$ ;  $p < 0.01$ ) diastolic BP. Conclusion: Walking capacity is inversely associated with ambulatory BP in patients with IC, which suggest that improving walking capacity may improve cardiovascular prognostic in these patients. Financial support: CNPq, FAPESP: 2009/17371-6, CAPES-PROEX

### NO EFFECT OF SIX MONTHS OF TRAINING ON THE HEMODYNAMIC RESPONSE TO METABOREFLEX ACTIVATION IN MULTIPLE SCLEROSIS PATIENTS

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Introduction One key symptom in patients with multiple sclerosis (MS) is exercise-related fatigue. Chronic deconditioning probably plays an important role in the genesis and progression of this phenomenon. Another important factor could be the MS-induced dysautonomia and cardiovascular dysregulation. Exercise training is a well established tool to counteract deconditioning and to improve physical capacity in MS patients (Moil 2010). However, its effect on the cardiovascular regulation in these patients is less known. The muscle metaboreflex activation is a well established tool to study the hemodynamic regulation during exercise (Crisafulli et al. 2003). We hypothesized that 6-months period of training, along with physical capacity, would also improve the hemodynamic response to the metaboreflex activation in MS patients. Methods The hemodynamic response to metaboreflex of 11 subjects with MS (5 females,  $46.8 \pm 10$  yrs, EDSS scale between 3 and 5.5) were studied by means of the post-exercise muscle ischemia at the beginning of the investigation (T0) and after 6-months (T6) period of supervised training (MSST group). Hemodynamic variables were collected by impedance cardiography. Patients'

physical capacity was also assessed by means of cardiopulmonary test (CPX). The same protocol was conducted on a control group of 11 patients with MS (CTL group, 3 females, 43.2±12.3 yrs, EDDS scale between 3 and 5.5) who did not participate in any training program. Results Training significantly affected the MSST group' physical capacity, as maximum VO<sub>2</sub> increased (+5.3±5.1 ml·kg<sup>-1</sup>·min<sup>-1</sup> at T<sub>6</sub> with respect to T<sub>0</sub>), whereas this phenomenon was not present in the CTL group. However, hemodynamic response was similar between groups at T<sub>0</sub>, and did not change at T<sub>6</sub>. Actually, stroke volume, cardiac output, systemic vascular resistance, and mean blood pressure were all unaffected by group and/or intervention. Conclusion This investigation demonstrates that supervised physical training programs can successfully enhance physical capacity in MS patients. However, this effect is unrelated to the cardiovascular regulation during exercise. Probably muscle deconditioning is the key factor in the progressive impairment of physical capacity in MS patients. References Motl RW. (2010) *Exerc Sport Sci Rev*, 38:186-191. Crisafulli A, Scott AC, Wensel R, Davos CH, Francis DP, Pagliaro P, Coats AJ, Concu A, Piepoli MF. (2003) *Med Sci Sports Exerc*, 35: 221-228. Contact: elisamar84@gmail.com

### **SPECIFIC TYPE 1 FIBRE HYPERTROPHY AND MYONUCLEAR ADDITION AFTER LOW-LOAD BLOOD FLOW RESTRICTED RESISTANCE EXERCISE IN NATIONAL LEVEL POWERLIFTERS**

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**INTRODUCTION:** Blood flow restricted resistance exercise (BFRE) is known to induce muscle mass gains in athletes (Takarada et al. 2002). However, BFRE has not been investigated in highly trained strength athletes. The present study investigates the effects of two blocks of low-load BFRE on muscle area, myonuclear responses and strength during six weeks of periodized strength training in powerlifters. **METHODS:** Seventeen national level powerlifters (25±6 yrs (mean±SD); 15 men) volunteered for the study. They were randomly assigned to either a BFRE group (n=9) performing two blocks (wk 1 and wk 3) of five BFRE front squat sessions during the 6-week strength training period, or a control group (CON; n=8) performing normal front squats (~70% of one repetition maximum (1RM)). The BFRE protocol consisted of four sets to voluntary failure (30 s rest between sets) at 25-30% of 1RM. To restrict the blood flow, elastic knee bands were wrapped around the upper thighs to a pressure of ~120 mmHg (verified with an underlying pressure cuff in the first session). Muscle biopsies were obtained from m. vastus lateralis and analysed for muscle fibre area (MFA), fibre type and myonuclei. Cross sectional area (CSA) of m. vastus lateralis and m. rectus femoris was measured using ultrasound imaging. Strength was measured as isokinetic peak torque in knee extension at 60 deg/s. **RESULTS:** The BFRE group showed a significantly larger increase of type 1 fibre MFA (BFRE: 11.7±8.2% vs. CON: 0.1±5.3%; p=0.003) and myonuclear number (BFRE: 17.8±12.8% vs. CON: 0.4±12.9%; p=0.01). No changes were observed in type II fibre MFA or myonuclear number. CSA of m. vastus lateralis increased more in the BFRE group than in the CON group (7.7±6.5% vs. 0.5±4.3%, p=0.04) and m. rectus femoris CSA also tended to increase more in the BFRE group (BFRE: 6.8±7.5% vs. CON: 1.4±3.9%; p=0.09). Although isokinetic peak torque in knee extension did not change significantly in any of the groups, we observed a significant correlation between the changes in isokinetic peak torque, and the changes in MFA of the type 1 fibres in the BFRE group (r=0.77; p=0.014). Furthermore, the changes in isokinetic peak torque was also correlated with the mean summed CSA of m. vastus lateralis and m. rectus femoris (r=0.68; p=0.045). **DISCUSSION:** We speculate that the type 1 fibre specific hypertrophy and increase in myonuclear number were due to a greater metabolic stress in these fibres during the BFRE protocol. Indeed, Cumming et al. (2014) showed that local stress responses were more pronounced in type 1 than in type 2 fibres after low-load BFRE. In conclusion, the larger gains in muscle CSA after low-load BFRE appeared to be caused by preferential hypertrophy of the type 1 fibres. Thus, it may be that using BFRE in combination with traditional strength training can be of importance to optimizing adaptation of both fibre types in highly strength-trained individuals. References: Takarada et al. *Eur J Appl Physiol* 86(4): 308-14, 2002 Cumming et al. *Acta Physiologica*, 211(4): 634-46, 2014 Contact: thomas.bjornsen@uia.no

### **MUSCLE LACTATE AND H<sup>+</sup> ACCUMULATION FACILITATES EARLY RECOVERY AFTER INCREMENTAL EXERCISE TO EXHAUSTION: DEMONSTRATION IN HUMANS.**

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**Introduction** The aim of this study was to determine if task failure during whole body incremental exercise (WBIE) is caused by muscle metabolite accumulation leading to metabolic blockade or reduced availability of energy resources. We hypothesized that task failure is not primarily caused by muscle lactate and H<sup>+</sup> accumulation. **Methods** Sprint performance (10s all-out isokinetic) and muscle metabolites were measured before (control) and immediately after a WBIE in normoxia (Nx, PIO<sub>2</sub>:143 mmHg) or severe hypoxia (Hyp, PIO<sub>2</sub>:73 mmHg) in 22 physically active men (22±3 years). For the sprint test after WBIE, subjects recovered for either 10 or 60s, with open circulation or bilateral leg occlusion (OC) (300 mmHg applied instantaneously, Hokanson). Immediately after the 10 or 60s OC the cuff was released and the 10s sprint performed. NIRS was used to monitor oxygenation changes. Leg VO<sub>2</sub> was measured by the Fick method. Results Peak (W<sub>peak</sub>) power output during post-WBIE sprints was higher than the W<sub>max</sub> at the end of the WBIEs (P<0.05). Compared to the control sprints, W<sub>peak</sub> was more reduced after recovery with OC than without (P<0.05). The mean reductions in W<sub>peak</sub> without OC were: 38±9 and 22±10% (P<0.05) and 61±8 and 47±10% (P<0.05) with OC, following 10 and 60s recoveries, respectively. In the sprint after 10s recovery, W<sub>peak</sub> was lower after WBIE in Nx than Hyp. At 10s post WBIE, muscle lactate ([La]) was increased (112±29 and 106±32 mmol.kg d.w.<sup>-1</sup>, in Nx and Hyp, respectively, P<0.001) and PCr and ATP reduced (Nx vs Hyp: P>0.10). From the 10th s to the 60th s OC period, [La] increased by 29 and 26 mmol.kg d.w.<sup>-1</sup> in Nx and Hyp, respectively (P<0.01), and pH decreased by ~0.10 units (P<0.05). Exercise performance and the mean rate of anaerobic ATP resynthesis were greater during the sprint that followed 60 compared to 10s occlusions, despite the higher [La] and [H<sup>+</sup>] after 60s than 10s OC recovery (P<0.05). The mean rate of ATP turnover during the 60s OC was 0.216±0.160 mmol.kg d.w.<sup>-1</sup>·s<sup>-1</sup>, i.e., equivalent to 40% of leg VO<sub>2peak</sub> (the energy expended by the ions pumps). **Discussion and conclusions** During WBIE task failure is not due to metabolite accumulation or lack of energy resources. Compared to Hyp, a greater level of fatigue is observed at exhaustion during the WBIE in Nx. Anaerobic metabolism, despite lactate and H<sup>+</sup> accumulation, facilitates early recovery after exhaustive exercise, even in anoxia, as indicated by NIRS. However, a greater degree of recovery is achieved with O<sub>2</sub>. These experiments indicate that task failure at the end of WBIE is predominantly caused by central mechanisms both in normoxia and hypoxia. Acknowledgements MINECO Spain (DEP2009-11638).

## Oral presentations

### OP-PM01 Sports Medicine

#### IS NERVE DEGENERATION A FEATURE OF TENDINOPATHY? STUDIES ON MIDPORTION ACHILLES TENDINOPATHY AND TENNIS ELBOW

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**Introduction** Chronic tendinopathy with marked pain is a troublesome condition that is frequently occurring for sports-active individuals. The mechanisms behind the pain are still unclear. It is likely that the peripheral nervous system is involved but it is not clear in what way. There are frequent nerves outside tendon tissue, i.e. in the peritendinous connective tissue (Andersson et al., 2007). They can signal pain. However, are the nerves that are present subjected to changes, such as nerve degeneration, in relation to the chronic tendinopathy? **Methods** Samples from the midportion of the Achilles tendon and the nearby located plantaris tendon in individuals with midportion Achilles tendinopathy and samples from extensor muscle origin at the lateral epicondyle of the humerus in patients with tennis elbow were investigated. Immunohistochemistry and markers for innervation were applied. Much focus was devoted to the reaction patterns for the general nerve marker PGP9.5 in relation to the Schwann cell marker S-100 $\beta$ . **Results** There was a marked PGP9.5 innervation in the peritendinous connective tissue located inbetween the Achilles and plantaris tendons. To some extent there was also an innervation in the connective tissue spaces within the plantaris tendon. There was also a pronounced innervation in the connective tissue related to the extensor muscle origin of the epicondyle. Most interestingly, it was noted that parts of some of the nerve fascicles in both Achilles/plantaris and epicondyle regions lacked PGP9.5 immunoreaction. There was on the other hand an overall and homogenous S-100 $\beta$  immunoreaction. These nerve fascicles did not show a normal morphology, as evidenced via staining for morphology markers (Htx-eosin). **Discussion** The observations show that there is not only a large amount of innervation in the tendon/muscle origin regions examined but also signs favouring that nerve degeneration has occurred. This is a new aspect in relation to nerve involvement in chronic tendinopathy. It is thus possible that there is a reorganization of the innervation in chronic cases of tendinopathy that includes the occurrence of nerve degeneration. This can be a drawback for the overall function in the tendon regions, including a drawback for sport activities. **References** Andersson G, Danielson P, Alfredson H, Forsgren S. (2007). *Knee Surg Sports Traumatol Arthrosc*, 15(10), 1272-1279. Contact Christoph.spang@umu.se

#### THE EFFECTS OF SHORT-TERM LOW ENERGY AVAILABILITY ON BONE TURNOVER IN WOMEN

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A dose-response relationship between energy availability (EA) and bone turnover at a threshold of 30 kcal/kgLBM/d has been shown in sedentary women (Ihle and Loucks, 2004). Bone turnover has not been assessed in physically active women under low EAs, which might be more relevant to those achieved in practice (Thong et al., 2000). **PURPOSE:** To investigate the short-term effects of low EA through combined dietary restriction (DR) and exercise energy expenditure (EEE) on bone turnover in women. **METHODS:** Using a randomised cross-over design, 11 women (age: 26  $\pm$  5y; mean SD) completed two 9-day trials with controlled (CON) or restricted (RES) (45 or 15 kcal/kgLBM/d) EA. A 3-day lead-in period (habitual dietary intake and no exercise) was followed by a 5-day experimental protocol (Days 4-8) at one of the two EAs. Participants started Day 4 in the early follicular phase of two menstrual cycles. They ran daily on a treadmill at 70% VO<sub>2</sub>max, resulting in an EEE of 15 kcal/kgLBM/d and consumed diets providing 60 and 30 kcal/kgLBM/day in order to achieve the CON and the RES EAs. Blood samples were collected on Days 1, 3, 5, 7 and 9. Plasma or serum was analysed for bone turnover markers: CTX and PINP and regulatory markers (sclerostin, PTH, leptin, IGF-1, GLP-2, T3 and insulin). Percentage changes from baseline (BAS) were calculated and used to determine the area under the curve (AUC) for all variables during both trials (% BAS change x time (in days)). **RESULTS:** Body mass was significantly reduced in the RES trial (D4: 60.2 $\pm$ 6.2; D9: 58.6 $\pm$ 6.2 kg; p<0.001) but maintained in CON (D4: 59.9 $\pm$ 6.5; D9: 59.5 $\pm$ 6.7 kg; p=0.237). PINP was significantly lower with RES (CON:-27.0 $\pm$ 34.2; RES: -56.1 $\pm$ 29.0 % BAS change x day; p<0.05), whereas CTX approached significance (CON: 14.5 $\pm$ 71.3; RES: 82.5 $\pm$ 66.5 % BAS change x day; p=0.061). Sclerostin, leptin, T3 and insulin decreased significantly in response to low EA (p<0.05), but PTH, IGF-1 and GLP-2 did not change (p>0.05). **CONCLUSION:** Five days of 15 kcal/kgLBM/day EA through DR and EEE, decreased bone formation in women, with a trend towards increased bone resorption. The level of EA in this study has been observed in amenorrhoeic athletes who are at high risk of bone disorders. The disruption in bone turnover with short-term energy restriction may lead to a net loss of bone and, in the long-term, impaired bone health. This study supports the importance of avoiding low EA and ensuring adequate dietary intake during training in women. **References** Ihle R, Loucks AB. (2004). *J Bone Miner Res*, 19(8):1231-40. Thong FS. (2000). *J Appl Physiol*, 88(6):2037-44.

#### EXERCISE TRAINING REDUCES ACUTE PHYSIOLOGICAL SEVERITY OF MENOPAUSAL HOT FLASHES

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**INTRODUCTION:** Menopausal hot flashes (HFs) occur due to the reduction in oestrogen that causes thermoregulatory and vascular dysfunction. A HF consists of a feeling of intense heat, skin reddening, profuse elevations in cutaneous vasodilation (CVC), sweating and heart rate, accompanied by reduced blood pressure and brain blood flow (Lucas et al., 2013). It is the combination of these factors that define HF severity. Exercise training enhances thermoregulatory control of sweating, CVC and improves brain blood flow. It is currently unknown whether the acute physiological severity of HFs is responsive to intervention. Our aim was to examine the impact of exercise training on HF-induced thermoregulatory and (cerebro)vascular perturbations. We hypothesised that exercise training would reduce the exaggerated thermoregulatory and (cerebro)vascular changes that occur during HFs. **METHODS:** Seventeen symptomatic post-menopausal females underwent a passive heat stress (48°C water-perfused suit) to induce HFs before and after a 16-week supervised exercise training intervention (n=10, 52 $\pm$ 4y, 29 $\pm$ 6 kg/m<sup>2</sup>) or no-exercise control (n=7, 52 $\pm$ 6y, 30 $\pm$ 7 kg/m<sup>2</sup>). Sweat rate (capacitance hygrometry), CVC (laser Doppler flowmetry), blood pressure, heart rate and middle cerebral artery velocity (MCAv; transcranial Doppler) were measured during the HFs that occurred with heating. The HFs were objectively identified based upon change in chest sweat rate and divided into eight equal segments, with each segment representing 12.5% of HF duration for analysis. Females also subjectively

rated severity of HFs over a 7-day period prior to and following the intervention. Data were analysed using linear mixed models and are presented as mean (95% CI). RESULTS: Exercise training decreased HF duration by 63s (95% CI: 14, 113) compared to 17s (95% CI: -43, 66) following control (P=0.08). Exercise training reduced subjective HF severity compared to control [101 (121, 80) vs 9 (37, 20) AU] (P<0.005). During the HFs sweat rate decreased by 0.04 mg·cm<sup>2</sup>·min<sup>-1</sup> (95% CI: 0.02, 0.06; P=0.01) and 0.03 mg·cm<sup>2</sup>·min<sup>-1</sup> (95% CI: 0.02, 0.05; P=0.03) at the chest and forearm following exercise training compared to no change in control. This was accompanied by a reduction of 9 %CV<sub>Cmax</sub> (95% CI: 6, 12; P=0.01) and 7 %CV<sub>Cmax</sub> (95% CI: 4, 9; P=0.05) at the chest and forearm following exercise training compared to no change in control. MCA<sub>v</sub> was attenuated by 3.4 cm/s (95% CI, 0.7, 5.1) during a HF following exercise training compared to control [0.6 cm/s (95% CI, -0.7, 1.8) P=0.04]. CONCLUSIONS: This is the first study to demonstrate that objectively measured physiological responses that occur during HFs can be reduced with an exercise intervention. The reduction in HF severity in symptomatic menopausal females is likely mediated via improvements in thermoregulatory and systemic vascular function, altering the exaggerated responses typically observed during HFs. Lucas R et al. (2013). *Menopause*, 20, 299-304.

### URINARY CONCENTRATIONS OF SINGLE AND MULTIPLE ADMINISTRATION OF INHALED AND ORAL TERBUTALINE: INFLUENCE OF GENDER AND ETHNICITY

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Introduction Elite athletes have a higher prevalence of Exercise-induced bronchoconstriction (EIB) than the general population. Treatment for asthma and EIB includes inhalation of short-acting β<sub>2</sub>-agonists (SABA). The World Anti-Doping Agency (WADA) has permitted the use of the SABA salbutamol for inhalation in therapeutic doses since 2010. In contrast, therapeutic doses of the inhaled SABA terbutaline still require a therapeutic use exemption. The purpose of the present study was to measure the urine concentrations of terbutaline following single and repeated doses of oral and inhaled terbutaline in Caucasian males, Caucasian females, Afro-Caribbean males and Asian males to distinguish between routes of administration and to allow for comparisons between gender and ethnicity. Methods Twenty-two male and eight female subjects (8 male & 8 female Caucasian, 6 male afro-Caribbean, 6 male Asian) were recruited for the study. All participants were free from asthma, EIB and AHR confirmed by no history of disease and a negative eucapnic voluntary hyperpnoea (EVH) challenge. Participants were assigned to one of four groups in a cross-over design: 1. Single dose of 5 mg oral terbutaline. 2. Single dose of 4 inhalations of 0.5 mg terbutaline totalling 2mg inhaled. 3. Repeated doses of 1 mg (2 x 0.5 mg inhalations) of terbutaline at 08:00h, 12:00h, 16:00h and 20:00h for 2 days. 4. Repeated doses of 5 mg oral terbutaline at 10:00h and 18:00h for 2 days. Participants were required to provide urine samples at 1h, 3h, 6h and 12h time-points post-final dose. Results The study identified upper thresholds following inhaled (1,500 ng·ml<sup>-1</sup>) and oral (2,000 ng·ml<sup>-1</sup>) administration which could be used to identify the use of supra-therapeutic doses of terbutaline. Gender differences existed (406.9±45.4 vs. 678.8±94.8 ng·ml<sup>-1</sup>; P=0.018) for male vs. female Caucasians, respectively following multiple oral administration. Ethnic differences (372.14 ± 69.7 vs. 131.8 ± 19.7 ng·ml<sup>-1</sup>; P=0.005) were identified following single inhaled administration for male Caucasians and male Asians, respectively. Discussion All trials resulted in the presence of terbutaline in urine. Upper thresholds for urinary terbutaline following inhaled and oral administration were observed along with gender differences between male and female Caucasians, and ethnic differences between male Asians and Caucasians. These upper thresholds could be useful in establishing anti-doping limits that can distinguish between routes of administration. Further investigation is warranted in order to fully elucidate these findings. Future research should examine urine concentrations following a minimum therapeutic dose of inhaled terbutaline versus oral terbutaline to provide further distinction between routes of administration.

### FOLLOWING PHYSICAL ACTIVITY RECOMMENDATIONS AND NORMAL WEIGHT ARE ASSOCIATED WITH LOW STRESS AND GOOD RECOVERY

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1:JYU(Jyväskylä, Finland), 2:TUT(Tampere, Finland) Introduction Physical inactivity and work-related stress are major concerns in today's society. However, physical activity is one of the factors that protects against stress. As known, psychological stress causes sympathetic responses such as reduced heart rate variability (HRV) as for repeated bouts of exercise lead to physiological adaptations, including increased parasympathetic activity. The aim of this study was to investigate the prevalence of HRV-based stress and recovery according to the individuals' compliance with general aerobic physical activity recommendations and body mass index (BMI). Methods The participants of this cross-sectional study consisted of a sample of 9200 Finnish employees (4056 men and 5144 women; age 18-65 years; BMI 18.5-40.0 kg/m<sup>2</sup>) who participated in wellbeing assessment related to occupational health promotion. The novel methodology used to determine the prevalence of stress, recovery and physical activity was provided by Firstbeat Technologies Ltd (Jyväskylä, Finland) and is based on HRV data from beat-to-beat R-R interval recording over 1-3 workdays (Mutikainen et al., 2014; Teisala et al., 2014). Physical activity was calculated on the basis of ≥10-minute bouts and participants were divided in the following groups: inactive (0 min), low (0<150min), medium (150-300min), high (>300min), based on weekly physical activity. BMI was calculated from the self-reported weight and height. BMI groups were following: 18.5-<25 kg/m<sup>2</sup>, 25-<30 kg/m<sup>2</sup> and 30-40 kg/m<sup>2</sup>. Results Moderate physical activity at least 150min/week was adhered to by 54.5 percent of men and 33.0 percent of women. Furthermore, 32.0 percent of the men and 15.6 percent of the women were classified as highly physically active. Stress percentage during the day decreased and the magnitude of recovery reactions during sleep increased with increasing physical activity and decreasing BMI (P<0.001 for all, in both men and women). Discussion Regular physical activity is known to reduce the risk of many adverse health outcomes. Furthermore, activity exceeding the level of general recommendations is suggested to have additional health benefits. This is supported by our results which suggest that high physical activity and low BMI are associated with objectively measured low stress and high recovery. References Mutikainen S, Helander E, Pietilä J, Korhonen I, Kujala UM. (2014). *BMJ Open*, doi:10.1136/bmjopen-2014-005927 Teisala T, Mutikainen S, Tolvanen A, Rottensteiner M, Leskinen T, Kaprio J, Kolehmainen M, Rusko H, Kujala UM. (2014) *JOMT*, doi:10.1186/1745-6673-9-16 Contact tiina.m.fohr@jyu.fi

## GLUCOSE AND HORMONE RESPONSE TO INTERMITTENT VS. CONSTANT LOAD EXERCISE IN TYPE 1 DIABETES MELLITUS USING NEW ULTRA-LONG-ACTING INSULIN

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Introduction Blood glucose (BG) decrease was shown to be lower in high-intensity exercise compared to moderate exercise in T1DM (Iscove and Riddell, 2011). In healthy subjects no difference in acute metabolic response between short high-intensity interval exercise (HIIE) and constant load exercise (CON) matched for mean load (Pmean) and duration could be found (Tschakert et al., 2015). The aim of this study was to investigate BG and hormone response in patients with T1DM performing HIIE and CON matched for Pmean and duration applying new ultra-long-acting insulin. Methods 7 male subjects with T1DM (24.7 ± 5.3 years, HbA1c: 7.4 (57) ± 0.6 (6.3) % (mmol.mol<sup>-1</sup>)) were adjusted to insulin Degludec (Tresiba/ Novo Nordisk, Denmark). Subjects performed a maximal incremental cycle ergometer exercise test to determine exercise intensities for subsequent CON and HIIE (Hofmann et al., 1994). Pmean was set at 5% of maximal power below (A) and above (B) the first lactate turn point (LTP1) and below the second lactate turn point LTP2 (C). Short-acting insulin reductions of 25% (A), 50% (B), and 75% (C) were applied after standardized meals according to Pmean. Adrenaline, noradrenaline, dopamine, cortisol, glucagon and IGF-1 were determined from venous blood samples. BG was obtained every 5 min and pulmonary gas-exchange variables were measured for indirect calorimetry. Continuous glucose monitoring (CGM) was used 24h pre- and post-exercise. Results were compared with paired Student's t-test or Wilcoxon signed-rank test (p<0.05). Results In HIIE, BG decrease was significantly lower compared to CON for B (1.51 ± 0.91 vs. 3.00 ± 1.54 mmol.l<sup>-1</sup>, p<0.05) and tended to be lower for A (1.27 ± 0.96 vs. 2.01 ± 1.04 mmol.l<sup>-1</sup>) and C (2.90 ± 1.35 vs. 3.42 ± 2.34 mmol.l<sup>-1</sup>). No difference was found for hormones and carbohydrate consumption. 24h post-exercise interstitial glucose was significantly less decreased in HIIE compared to CON for A, B and C. Discussion Despite the same short-acting insulin administration, matched Pmean and duration and no differences in hormonal response, BG was higher in HIIE during- and 24h after exercise compared to CON. Therefore, we suggest, short-acting insulin adaptation is also dependent on exercise mode and has to be regarded to avoid post-exercise glycemic disturbances when applying ultra-long-acting insulin Degludec. References Iscoe KE, Riddell MC. (2011). *Diabetic Med*, 28, 824-832. Tschakert G, Kroepfl J, Mueller A, Moser O, Groeschl W, Hofmann P. (2015). *J Sports Sci Med*, 14, 29-36. Hofmann P, Bunc V, Leitner H, Pokan R, Gaisl G. (1994). *Eur J Appl Physiol*, 69, 132-139. Contact [omoser@uni-potsdam.de]

## Oral presentations

### OP-PM03 Exercise Metabolism, Mitochondrial Function and Body composition

#### MODERATE INTENSITY EXERCISE TRAINING RAPIDLY INCREASES INSULIN STIMULATED INTESTINAL GLUCOSE UPTAKE IN SEDENTARY INDIVIDUALS.

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Abstract: Recently it has been shown that insulin is a potent stimulator of glucose uptake (GU) in intestine and that intestinal insulin resistance manifests in obesity and type 2 diabetes. Exercise improves whole body glycaemia and insulin stimulated skeletal muscle GU. Thus, we aimed to study the tissue specific effects of exercise training and training intensity on insulin stimulated intestinal GU. Materials and methods: Healthy individuals (n=26, aged=48 [SD 5] yrs, BMI=26.1 [SD 2.4] kg•m<sup>-2</sup>, VO<sub>2</sub>peak=34.2 [SD 4.1] ml•kg<sup>-1</sup>•min<sup>-1</sup>) and patients with IFG/IGT/T2D (n=20, aged=49 [SD 4] yrs, BMI=30.1 [SD 2.7] kg•m<sup>-2</sup>, VO<sub>2</sub>peak=28.3 [SD 4.6] ml•kg<sup>-1</sup>•min<sup>-1</sup>) were randomized into high intensity interval training (HIT) and moderate intensity training (MIT) groups. The groups were studied before and after two weeks and six sessions of HIT (4-6x30 s all out sprints on cycle ergometer with 4 minutes of recovery) or MIT training (40-60 min cycling with ergometer at 60 % of VO<sub>2</sub>max). Insulin-stimulated intestinal GU was studied during euglycemic hyperinsulinemic clamp using positron emission tomography and 18F-FDG. Results: In healthy individuals, VO<sub>2</sub>peak and whole body insulin sensitivity improved and visceral fat decreased similarly in both groups (all p<0.05), following intervention. Training increased GU in colon and tended to increase in small intestine in MIT group, whereas opposite was observed in HIT group [GU: HIT - 2%, MIT 30% (p=0.02) and GU: HIT - 9%, MIT 10% (p=0.08), respectively]. The GU in the small intestine correlated positively with the VO<sub>2</sub>peak [Pre: r= 0.46 p=0.03; Post: r=0.45 p= 0.03] and negatively with visceral fat mass [Pre: r=-0.42 p=0.05; Post: r=-0.45 p=0.03]. The results for IFG/IGT/T2D group are under analysis and will be presented in the congress. Conclusion: This study suggests that MIT rapidly enhances insulin stimulated intestinal GU already after two weeks of training in sedentary individuals.

#### GENDER DIFFERENCES IN MITOCHONDRIAL OXIDATIVE CAPACITY AFTER WEIGHT REGAIN FOLLOWING A LIFESTYLE INTERVENTION

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Introduction: The study aim to examine muscle mitochondrial oxidative capacity, in subjects who successfully maintained a weight loss following a lifestyle intervention (LI), versus subjects who regained weight. We hypothesized that those who maintained weight loss would have been more compliant to the lifestyle changes and therefore would show a higher mitochondrial oxidative capacity than those who regained weight after the LI. Methods: In a cross-sectional study, we included 59 subjects who had completed a LI of 10-14 weeks, focusing on diet and physical exercise and the average time to follow up was 4.8 ± 0.4 yrs. All had lost at least 5 % of bodyweight during the LI (11.9 ± 0.5 %). 17 females (33 ± 3 yrs.) and 10 males (39 ± 4 yrs.) had maintained the entire weight loss from the LI and were grouped as Maintainers (M). 18 females (36 ± 4 yrs.) and 14 males (39 ± 2 yrs.) had regained the entire weight loss and were grouped as Non-Maintainers (NM). A muscle biopsy was obtained from m. vastus lateralis and permeabilized before examination for maximal mitochondrial respiratory capacity (state 3 respiration) using high resolution respirometry (Oxygraph-2k, Oroboros, Innsbruck, Austria). VO<sub>2</sub>PEAK was measured by a graded cycle exercise test until exhaustion. Body composition was determined by DXA. Statistical analysis was performed by 2-way ANOVA (Sigmaplot 12) and data are presented as mean ± SEM. Results: Female M vs. female NM showed no differences in mitochondrial state 3 respiration (59.6 ± 4.3 vs. 59.6 ± 4.3 pmol/mg/sec, p=0.995) and in uncoupled respiration (70.6 ± 4.9 vs.

73 ± 4.9 pmol/mg/sec,  $p=0.725$ ). In contrast, male M showed a significantly higher state 3 respiration (68.4 ± 5.6 vs. 45.9 ± 5 pmol/mg/sec,  $p=0.004$ ) than male NM, and a higher uncoupled respiration (79 ± 6.3 vs. 58 ± 5.7 pmol/mg/sec,  $p=0.019$ ). The VO<sub>2</sub>PEAK adjusted to fat free mass (FFM) was significantly higher in M vs. NM among males (153.1 ± 13 vs. 78.7 ± 12,  $p<0.001$ ml/min/kg FFM) but not females (66 ± 11 vs. 48.7 ± 10.1,  $p=0.245$ ). Discussion: In the male group we found an expected lower VO<sub>2</sub>PEAK/FFM in NM than in M, but we did not find the same significant difference between M and NM in the female group. This might explain why the hypothesized lower oxidative capacity in muscle mitochondria is found among the NM men but not among the NM women. It seems that women, who regain weight after a LI, still manage to maintain their mitochondrial oxidative capacity whereas men do not.

### CHRONIC NON-STEROIDAL ANTI-INFLAMMATORY DRUG INGESTION BLUNTS INCREASES IN MUSCLE MITOCHONDRIAL FUNCTION DURING RESISTANCE EXERCISE TRAINING IN HUMANS

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**Introduction** Non-steroidal anti-inflammatory drugs (NSAIDs) regulate the inflammatory response by inhibiting cyclooxygenase-mediated prostaglandin production. NSAIDs have been associated with the impairment of mitochondrial function in vitro (Mingatto et al., 1996) and in rodent cardiac muscle (Moreno-Sanchez et al., 1999). NSAID use by athletes is unregulated and extensive (Tscholl et al., 2008). Whether NSAIDs affect training-induced mitochondrial adaptation in human skeletal muscle is unknown and was the focus of this study. **Methods** Following local ethics approval, 16 resistance exercise-familiar males matched for strength were randomly assigned to either placebo ( $n=7$ , age 25 ± 5 yrs, ht 1.83 ± 0.04 m and mass 78.7 ± 8.4 kg) or NSAID ( $n=9$ , age 26 ± 4 yrs, ht 1.80 ± 0.03 m and mass 80.6 ± 9.7 kg) treatment groups. Volunteers consumed 75 mg slow-release diclofenac and 15 mg lansoprazole per day or placebos for 12 wk. Concomitantly, subjects completed 5 × 30 maximal concentric isokinetic knee extensions 3d/wk for 12 wk (randomly assigned leg). Vastus lateralis biopsies were taken at baseline, 4 and 12 wk for analysis of maximal ATP production rates (MAPR) and activities of electron transport chain (ETC) complexes. Data were normalised for mitochondrial protein content and were analysed using two-way ANOVA with Bonferroni post-hoc tests. **Results** There was an increase in succinate dehydrogenase (SDH; complex II) activity in placebo (mean ± SEM; 4 wk 37 ± 27 % and 12 wk 80 ± 54 %) that was blunted by NSAID administration at 4 (1.7 ± 14 %) and 12 (-16% ± 14 %) wk of training (treatment effect:  $P<0.01$ ). Moreover, there was a greater increase in succinate MAPR in placebo than NSAID treatment at 4 (252 ± 118 % vs. 48 ± 10 %,  $P<0.05$ ) and 12 wk (223 ± 78 % vs. 95 ± 35 %,  $P=0.01$ ). There was no change in the activity of complex I, I and III, II and IV or IV and no change in MAPR with substrates which deliver to complex I over 12 wk training or between treatments. **Discussion** NSAID administration specifically blunted exercise-induced increases in SDH activity and succinate mediated MAPR. This inhibitory effect therefore appears to be localised to complex II of the ETC. The relevance of these findings to muscle physiology and athletic performance warrants further investigation. **References** Mingatto FE, Santos AC, Uyemura SA, Jordani MC, Curti, C. (1996). Arch Biochem Biophys, 334, 303-8. Moreno-Sanchez R, Bravo C, Vasquez C, Ayala G, Silveira LH, Martinez-Lavin M. (1999). Biochem Pharmacol, 57, 743-752. Tscholl P, Junge A, Dvorak J. (2008). Br J Sports Med, 42, 725-730.

### MAXIMAL FAT OXIDATION DURING EXERCISE IS POSITIVELY ASSOCIATED WITH 24-HOUR FAT OXIDATION AND INSULIN SENSITIVITY IN YOUNG, HEALTHY MEN

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**Introduction** An elevated 24-hour (24-h) respiratory quotient (RQ; indicative of a low relative fat oxidation) has been associated with an increased risk of body mass gain (Zurlo et al., 1990) and regain of body fat mass after diet-induced weight loss (Ellis et al., 2010), while impairments in fat oxidation have been linked to metabolic disorders such as insulin resistance (Kelley & Simoneau, 1994). There is large inter-subject variability in the capacity to oxidise fat when physically active (Venables et al., 2005) although the significance of this for metabolic health is unclear. We investigated whether the maximal capacity to oxidise fat during exercise is related to 24-h fat oxidation and insulin sensitivity. **Methods** Maximal Fat Oxidation (MFO; determined from indirect calorimetry applied during incremental exercise) and insulin sensitivity (Quantitative Insulin Sensitivity Check Index) was determined in 53 healthy men (age 24±7 y; BMI 24.2±2.6 kg/m<sup>2</sup>; VO<sub>2</sub>max 52±6 ml/kg/min). 24-h Fat Oxidation (24-h FO) was assessed in 16 of these men by indirect calorimetry during a 36-h stay in a whole-room respiration chamber. **Results** MFO (g/min) was positively correlated with 24-h FO (g/d) ( $R=0.65$ ,  $P=0.003$ ;  $R=0.46$ ,  $P=0.041$ ) when controlled for VO<sub>2</sub>max (L/min), 24-h % energy from FO (%EnFO) ( $R=0.58$ ,  $P=0.009$ ) and insulin sensitivity ( $R=0.33$ ,  $P=0.007$ ). MFO (g/min) was negatively correlated with 24-h fat balance (g/d) ( $R=-0.51$ ,  $P=0.021$ ) but was not significantly correlated with 24-h RQ ( $R=-0.29$ ,  $P=0.142$ ). The findings were similar when MFO expressed relative to FFM (mg/kg FFM/min) was correlated with 24-h FO (g/kg FFM/d,  $R=0.70$ ,  $P=0.001$ ), 24-h %EnFO ( $R=0.60$ ,  $P=0.007$ ), 24-h RQ ( $R=0.31$ ,  $P=0.12$ ), and insulin sensitivity ( $R=0.39$ ,  $P=0.002$ ). **Discussion** The positive associations between MFO and 24-h fat oxidation, and MFO and insulin sensitivity, in healthy young men suggest that a high capacity to oxidise fat whilst physically active could be advantageous for the long-term maintenance of metabolic health. Future work should seek to establish if this is a causal relationship and address in a variety of subject populations the long-term implications of the apparent inter-subject variation in MFO during exercise and risk for disorders associated with disturbances in fat metabolism, such as obesity, insulin resistance and type II diabetes. **References** Ellis et al (2010). Obesity, 18: 2255-2259. Kelley & Simoneau (1994). J Clin Invest, 94: 2349-2356. Venables et al (2005). J Appl Physiol, 98: 160-167. Zurlo et al (1990). Am J Physiol Endocrinol Metab, 259: 650-657.

### STATIN MYALGIC PATIENTS HAVE IMPAIRED MITOCHONDRIAL RESPIRATORY FUNCTION IN SKELETAL MUSCLE

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**Introduction** Statins reduce endogenous cholesterol synthesis and is widely consumed to decrease the risk of cardiovascular events. However, a common side effect to statins is muscle ache and pain (myalgia), which is aggravated by exercise. Thus, statin therapy is a potential barrier to exercise. It has previously been demonstrated that statins decrease the muscle mitochondrial oxidative phosphorylation (OXPHOS) capacity (Larsen et al., 2013). However, the mechanism behind statin induced myalgia remains unclear. Thus, the aim of this study was to investigate if statin induced myalgia is coupled with impaired mitochondrial respiratory function in human skeletal muscle. We hypothesized that statin myalgic patients have impaired intrinsic mitochondrial respiratory function. **Methods** Two groups of healthy adults in continuous simvastatin treatment (40 mg/day) were recruited for this study. One group ( $n=9$ ) experienced myalgia (SM)

with a VAS score of  $4.5 \pm 0.8$ , and the other group ( $n=9$ ) without side effects (VAS  $0.4 \pm 0.3$ ) served as control (SC). The groups were matched for age, BMI, and  $VO_{2max}$  ( $61 \pm 2$  vs  $59 \pm 2$  yrs,  $30 \pm 2$  vs  $28 \pm 2$  kg/m<sup>2</sup> and  $26 \pm 2$  vs  $29 \pm 2$  ml O<sub>2</sub>/min/kg, respectively). Habitual physical activity level was determined using the International Physical Activity Questionnaire (IPAQ). Mitochondrial respiration was measured in permeabilized muscle fibers from the vastus lateralis using high-resolution respirometry. The protocols investigated maximal mitochondrial respiration with electron flow through complex (C) I, CII, CI+II simultaneously (OXPHOS capacity), and electron transport system (ETS) capacity. Results Maximal mitochondrial CII respiration, OXPHOS capacity, and ETS capacity were reduced in SM compared to SC ( $48 \pm 2$  vs  $54 \pm 2$  ( $P=0.015$ ),  $59 \pm 3$  vs  $69 \pm 5$  ( $P=0.028$ ), and  $68 \pm 3$  vs  $84 \pm 6$  ( $P<0.001$ ) pmol/mg/s, respectively). IPAQ-score was similar between groups ( $2603 \pm 758$  ( $n=8$ ) vs  $2368 \pm 606$  MET-min/week in SM and SC, respectively). In SM, the degree of myalgia (VAS) correlated with IPAQ-score ( $R=0.71$ ,  $P=0.03$ ). Discussion Interestingly, we found a coupling between myalgia and impaired mitochondrial respiratory function in skeletal muscle. Though statins are potent inhibitors of hepatic cholesterol synthesis, inhibition of the mevalonate pathway reduces synthesis of Ubiquinone (Q10) as well. Due to the lipophilic nature of simvastatin, it can easily penetrate the lipid membrane bilayers, and we speculate that accumulation of statin in muscle fibers decreases the amount of Q10, thereby impairing the intrinsic mitochondrial respiratory function, which may lead to myalgia. Contact Tine.dohmann@sund.ku.dk References Larsen S, Stride N, Hey-Mogensen M, Hansen C, Bang L, Bundgaard H, Nielsen L, Helge J, Dela F. (2013). JACC, 61(1), 44-53.

## DETERMINATION OF BODY FAT AND MUSCLE MASS IN UPPER BODY ATHLETES – A COMPARISON OF METHODS

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**Introduction** Body composition is a key determinant for athletic performance, particularly where a large muscle mass is required to maximise power output and lower body fat is beneficial. Creatine (methyl-d3) dilution (D3-creatine) is a novel technique for the estimation of muscle mass in humans and has recently been reported (Clark et al, 2014). The method uses a dose of D3-creatine to determine total skeletal muscle mass via estimation of total body creatine pool size. This study is the first to apply the D3-creatine method in athletic populations; further, it compares techniques for the determination of body fat and muscle mass in well-trained upper body athletes. **Methods** Fifteen male and five female national level kayakers (stature:  $182.0 \pm 13.1$  and  $170.0 \pm 9.0$  cm; body mass:  $80.6 \pm 9.9$  and  $66.4 \pm 6.0$  kg;  $VO_{2max}$ :  $56.5 \pm 7.0$  and  $49.6 \pm 4.4$  ml•kg<sup>-1</sup>•min<sup>-1</sup> for males and females, respectively) underwent body composition assessment at the start of pre-season training. Body fat was determined using three methods: whole body Magnetic Resonance Imaging (MRI); prediction from skinfolds (Yuhasz, 1962); and air displacement plethysmography (Cosmed, BodPod). Muscle mass was determined via two methods: MRI and D3-creatine. The D3-creatine technique required participants to ingest two 30mg capsules and total urine was collected at 0-4 and 4-24 hour time periods over four days. Urine aliquots were analysed for creatine, creatinine, D3-creatine and D3-creatinine using a triple quadrupole mass spectrometer. **Results** There was a significant difference ( $F = 8.904$ ,  $P = 0.000$ ) in body fat between measures (MRI =  $16.7 \pm 3.9$  %; prediction from skinfolds =  $10.6 \pm 3.8$ %; Bodpod =  $11.9 \pm 6.3$ %), with MRI being significantly different to prediction from skinfolds ( $P = 0.001$ ) and BodPod ( $P = 0.007$ ). Muscle mass data from the D3-creatine technique and comparison to MRI data ( $36.3 \pm 6.2$  kg;  $47.4 \pm 4.3$  %) will be presented. **Discussion** The D3-creatine technique is a novel and validated method for the determination of muscle mass in humans. This study is the first to have applied the technique in an athletic population, for whom the accurate and sensitive assessment of muscle mass is critical. Muscle mass measurements from the D3-creatine technique and comparison to MRI will be discussed. Prediction of body fat from skinfolds and BodPod was significantly lower than MRI measures in well-trained upper body athletes. Further research is required to determine the sensitivity of the D3-creatine technique to changes in muscle mass in athletic populations. **References** Clark, R.V., Walker, A.C., O'Connor-Semmes, R.L., Leonard, M.S., Miller, R.R., Stimpson, S.A., Turner, S.M., Ravussin, E., Cefalu, W.T., Hellerstein, M.K., Evans, W.J., (2014). Total body skeletal muscle mass: estimation by creatine (methyl-d3) dilution in humans. *Journal of Applied Physiology*, 116(12), pp.1605-1613 Yuhasz, M.S., (1962). The effects of sports training on body fat in man with predictions of optimal body weight. Unpublished Doctorial Dissertation, University of Illinois.

## Oral presentations

### OP-PM61 Health & Fitness: Age III

#### TELOMERE LENGTH IS ASSOCIATED WITH MOBILITY IN OLDER WOMEN, BUT DOES NOT PREDICT MOBILITY DECLINE DURING 11 YEAR FOLLOW-UP

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University of Jyväskylä

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no associations were observed in DZ twins. Conclusions Leucocyte telomere length is associated with PA level cross sectionally, but does not predict mobility decline in older females. Current findings that associations between telomere length and mobility tended to be stronger in MZ twins may suggest some genetic influences. References Cawthon et al. 2003 Lancet 361: 9355, 393-395. Tiainen et al. 2004 JAP 96:1, 173-180. Contact: elina.sillanpaa@jyu.fi

### EFFECTS OF A PROGRAM OF PHYSICAL ACTIVITY IN ELDERLY WOMEN

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Introduction Functional capacity decreases in the elderly and generally limits their Activities of Daily Living (ADL). The objective of this study was to apply a program of physical activity in elderly women to preserve or increase their physical fitness. Methods Thirty-five physically active women over 60 years (+/- 67years) performed a systematic physical activity program(3 times/week,50 min/session). The periodization (I) was divided in 3 blocks(8-12weeks): 1st Block-cardiorespiratory function; 2nd Block-flexibility, coordination and balance; and 3rd Block-strength. We evaluated their physical capacity three times: pre-testing (T1); at the end of the 2nd (T2); and the 3rd block (T3) (VO2max-1600m walk test, BMI, Waist-hip ratio (WHR), Bank of Wells test, Sock test, Get up from the floor test, Agility/Dynamic balance, Sitting-Rising test and Abdominal strength)(I2). We verified the normality and sphericity of the data (Shapiro-Wilk and Mauchly's) and applied the ANOVA test with repeated measures ( $p < 0.05$ ) to analyze the effectiveness of the training. Since the tests related to the evaluation of strength capacity were not performed after the 2nd block, we used a paired t-test ( $p < 0.05$ ). Results No significant difference was found in the mean values of the VO2max and Bank of Wells test. A significant increase was observed in the Floor Test and Agility/Dynamic balance (after 2nd Block). After T3, we found a significant improvement in the mean values of the Sitting-Rising, Abdominal test, the Sock Test, BMI and WHR. The mean value of Floor Test and Agility/Dynamic balance significantly decreased in T3 compared to T2; however, these values were not different compared to the pre-testing values. Discussion Each year the VO2max can decrease 1% and the loss of flexibility could limit the capacity to move thus increasing the probability of injury risk(3). Our results show that these capacities were maintained such that no physical capacity was lost. Because there was an increase in the mean values of T3 and BMI, we can assert that these women may have improved their ADL(I). WHR is considered a marker for the probability of having cardiovascular diseases, the decrease of this variable is a remarkable result. Since the elderly generally have an emphasized loss of their physical capacities, our results highlight the importance of regular physical activity which is indicated to be effective for the maintenance or improvement of their capabilities for this group. References (1)www.acsm.org (2)Clark BA. Tests for fitness in older adults:AAHPERD fitness task force. JOPERD.1989. (3)Spirduso, W.W. Physical Dimensions of Aging. Champaign:Human Kinetics,1995.432p. Acknowledgments: FAPEMIG, CAPES, CNPQ, Prefeitura Municipal de Viçosa Contact gracianefreitas@gmail.com

### 12 WEEKS OF FLOORBALL TRAINING LOWERS BODY FAT IN ELDERLY UNTRAINED MEN

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Aging is associated with adverse changes in body composition and physical function. Loss of muscle mass and a concomitant gain in body fat may consequently increase the risk of chronic diseases. However, it may be difficult to separate the effects of "true aging" (i.e. inherent aging) and a physical inactive lifestyle. This is supported by studies showing that life-long trained elderly subjects do not decline in physical function compared to age-matched sedentary counterparts (Lazarus & Harridge, 2010). Furthermore, exercise training can reverse the physiological degeneration observed with aging (Melov et al., 2007). Typical exercise training interventions for an elderly population include aerobic activities, e.g. cycling, walking, or strength training activities. Results from recent studies suggest that small-sided football training may represent a motivating and health promoting exercise alternative (Krustrup et al., 2010). However, none of these studies have so far investigated the effect of floorball training on body composition in elderly untrained men. Thus, the aim of the present study was to investigate the effects of floorball training on body composition in elderly untrained men. Twenty untrained subjects aged 65-77 years took part in the first round of a 12-week training intervention study. Of note, the study is on-going and fifty subjects total are expected to complete the training intervention, hence, the present results are preliminary. Subjects were randomized to either a floorball group (FLO; n=10) or a control activity group playing petanque (CON; n=10). Whole body fat content and fat free mass were determined before and after the 12-week training intervention using Dual-energy X-ray Absorptiometry (DXA), and fat free mass to fat mass ratio was calculated. Data are presented as mean  $\pm$  S.E.M compared by ANOVA. Visceral fat content and physical function, i.e. maximal oxygen uptake (VO2max), time to exhaustion during incremental cycling, and 6 min maximal walking distance were also examined (results not shown in abstract). In FLO, after 12 weeks of training, whole body fat content was 8.5% lower ( $25.8 \pm 3.4$  vs.  $28.0 \pm 3.3$  kg,  $P < 0.05$ ), whereas no change was observed in CON ( $24.9 \pm 2.8$  vs.  $25.2 \pm 2.8$  kg). In FLO, fat free mass to fat mass ratio tended to be higher with a 10.1% increase ( $2.65 \pm 0.54$  vs.  $2.40 \pm 0.46$ ,  $P = 0.08$ ), with no change observed in CON ( $2.48 \pm 0.29$  vs.  $2.44 \pm 0.27$ ). No change was observed in fat free mass in either FLO ( $57.8 \pm 2.4$  vs.  $56.9 \pm 2.1$  kg) or CON ( $55.1 \pm 1.6$  vs.  $55.4 \pm 1.6$  kg). Preliminary results indicate that 12 weeks of floorball training lowers whole body fat content, leading to a more favorable body composition in elderly untrained men. The on-going intervention study will add more knowledge to whether floorball training also positively affects visceral fat content and physical function.

### EXERCISE INTERVENTION CAN CHANGE SEDENTARY BEHAVIOR TO PHYSICAL ACTIVITY IN MIDDLE TO OLDER ADULTS BASED ON OBJECTIVELY-MEASURED HOURLY ACCELERATION

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Introduction The recent technological advances enable us to assess objectively the behavioral patterns under free-living condition. Although the accelerometer-based investigations have demonstrated the whole day habitual physical activity and sedentary behavior, the hourly patterns remains unclear. Therefore, the purpose of the present investigation was to examine the effects of 8-week exercise intervention on time spent in inactive/active time in middle to older adults based on objectively determined hourly physical activity. Methods A total of 30 adults participated in the present investigation, and were divided to exercise group and control group. The participants in the exercise group were instructed to increase the walking volume with targeting 23 METs  $\cdot$  hour/week according to the Japanese Exercise and physical activity reference for health promotion. All participants wore a pedometer with a one-axial accelerometer (Lifecorder, Kenz,



Japan) during all waking hours for 7 days, in order to determine their frequency (bouts) and duration of physical activity (min), and physical activity was divided by the intensity (Sedentary; <1.7 METs, Light; 1.7-3.0 METs, Moderate; >3METs). The bout and min of physical activity evaluated in hour-by-hour, thereafter, the sum of the hourly values was defined as the 24-hour indexes. Results The subjects in exercise group successfully improved the daily total amount of physical activity calorie expenditure, the number of steps, and the time spent in moderate to vigorous intensity physical activity ( $p < 0.05$ ). As results of the analysis in the hourly acceleration pattern, there were significant effects of exercise intervention on the time spent in sedentary behavior at 12:00 to 13:59 ( $p < 0.05$ ), similarly, the time spent in physical activity was increased at the same period ( $p < 0.05$ ). These significant changes were found in weekly days (Mon to Fri), but were not in weekend days (Sat and Sun). Discussion The exercise intervention can change the sedentary behavior to physical activity on day-time in middle to older-aged adults. The present investigation could not find the daytime transition from the sedentary behavior to the moderate to vigorous intensity physical activity. Contact ayabe@ss.oka-pu.ac.jp

### PHYSIOLOGICAL RESPONSES OF MEN IN RECREATIONAL SWIMMING AFTER A MAXIMAL SPRINT TEST - A PILOT STUDY

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Introduction One of the most important health problems in modern people is the repulsion from physical activity. Previous studies in master swimmers notice that before the age of 70, there are no significant differences in blood lactate (Benelli, et al., 2007; Tanaka & Seals, 1997), but lactate levels differ between middle age men that do physical activity and men that do not (Korhonen, Suominen & Mero, 2005). The aim of the present study was to determine differences in physiological responses between two male age groups, (29-37years) and (38-51years) after a sprint test of 100m freestyle swimming. Methods The sample of the research consisted of 20 health men and it was separated in two groups: a) 29-37 years and b) 38-51 years. They participated in a recreational swimming program 3 times per week lasting 60 min. The participants were not following other physical activity program. Their job was sedentary. They swam 100m freestyle swimming with maximum intensity. Total performance time and heart rate were measured. Furthermore, velocity drop from 1st to 4th 25m was calculated. After the effort, capillary samples were taken in the 3rd, 5th and 7th minute and were analyzed with scout Lactate Germany. Results For the identification of differences between the two groups, statistical analysis ANOVA was applied. Mean performance time in 100m was  $101,09 \pm 11,5$ sec and  $111,7 \pm 18,4$ sec for the first and the second group respectively. Blood lactate was  $11,4 \pm 2,7$ mmol/L and  $12,01 \pm 2,5$ mmol/L respectively. The results showed that there are no statistical significant differences between the two groups in the measured variables. Discussion Recreational swimming seems to reserve men's physical fitness level till the age of 50. This field needs further research with more variables, different tests in both genders in order to identify the benefits on people of middle age. References 1. Benelli, P., Ditroilo, M., Forte, R., De Vito, G. & Stocchi, V. (2007). Assessment of post-competition peak blood lactate in male and female master swimmers aged 40-79 years and its relationship with swimming performance. *European Journal of Applied Physiology*. 99:685-693. 2. Korhonen, M. T., Suominen, H. & Mero, A. (2005). Age and Sex differences in blood lactate responses to sprint running in elite master athletes. *Canadian Journal of Applied Physiology*, 30(6): 647-665. 3. Tanaka, H. & Seals, D. R. (1997). Age and gender interactions in physiological functional capacity: insight from swimming performance. *Journal of Applied Physiology*. 82: 846-851.

### FLIPPING THE CLASSROOM IN AN UNDERGRADUATE SPORTS COACHING COURSE

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Introduction There are increasing concerns in higher education of the need to move away from the traditional lecture format in order to more effectively prepare students as future leaders. Research in active learning has encouraged many tertiary educators to experiment with the flipped classroom approach that has been used extensively in K-12 educational programs. This paper describes the design, implementation and outcomes of a flipped classroom approach that was put into practice in Sports Coaching, a second-year course in the Bachelor of Exercise Science. Methods In semester 1, 2014, the redesigned course was delivered to 35 students. Three essential elements were implemented to support student learning in this change to the flipped classroom approach: (a) first exposure to content prior to class, (b) student-centred in-class activities; and (c) appropriately aligned assessment. In the final weeks of the course 32 students completed a questionnaire requiring responses to statements about their perception of the course, using a Likert scale and open-ended questions. Results The students reported that they experienced more constant and positive interactions with lecturers/peers than in other courses. Overall, a high level of commitment to the course was indicated, whilst group work, discussions and practical applications were also identified as positive aspects of the course. The mean total score for the quizzes undertaken in class was significantly higher than in previous years ( $p < 0.05$ ). Compared to the traditional lecture method, the perceived contributions of courses of the 'flipped classroom' used in this course were significantly different ( $p < .002$ ) in all aspects measured. The most common suggestions for improvement included providing more time for group tasks to allow increased discussion between classmates. A significant difference ( $p < 0.05$ ) in the responses of the 12 female and 23 male students was also found. However, no significant difference was noted between those students with English as their first language and NESB students. Discussion The positive outcomes of this curriculum change suggest that the flipped classroom model warrants consideration when planning courses to maximize student learning and engagement. Evidence suggests that students generally preferred the flipped classroom approach to a traditional lecture scenario. It is hoped that this research will stimulate tertiary educators to consider teaching and learning strategies to enhance the effectiveness of the flipped classroom approach. References Bergmann & Sams (2012). *Flip Your Classroom: Reach Every Student in Every Class Every Day*. ISTE. Findlay-Thompson & Mombourquette P (2014). *Business Education and Accreditation*. 6(1), 63-71. Toto & Nguyen (2009). 39th ASEE/IEEE Frontiers in Education Conference. Email: g.reddan@griffith.edu.au

## Oral presentations

### OP-BN14 Coaching: Team sport II

#### DEVELOPMENT OF WORKING MEMORY TRAINING PRINCIPLES AND INTEGRATION INTO 'ONE ON ONE' FOOTBALL COACHING

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This research is an investigation on the effects of working memory training (WMT) on skill performance and psychosocial state in adult football players. Current practice in coaching allows for the pursuit of physical, technical, tactical and psychosocial outcomes in any exercise. This research is investigating how WMT will be combined with football coaching practice to produce neurological outcomes that will increase performance. WMT is used to affect working memory, which deals with the manipulation of information and the making of decisions under five seconds. A systematic literature review was performed on the field of WMT and data analysis revealed trends in effective methodology. The review found that WMT creates performance gains in both task-specific and task transfer tests. Further qualitative analysis, using a clinical methodology, identified trends that were used to form a series of training principles and pinpoint key WMT tasks required for integration into periodised training. The WMT principles identified account for task specificity, recovery, training duration and difficulty progression. The N-back and digit span forward/backward tasks have been identified as the key tasks for successful WMT, and have subsequently been organised into specific difficulty levels for the purpose of periodisation and assessment. The WMT principles have been used to theorise the future of coaching footballers in a one on one format -found in TA (Talent Acceleration) programs encouraged by national associations. The research aims to improve the benefits of coaching footballers individually outside of team training to improve performance and accelerate development.

#### COACHES' BEHAVIOR IN BASQUE TRADITIONAL ROWING

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**COACHES' BEHAVIOR IN BASQUE TRADITIONAL ROWING** Introduction Traditional rowing is a type of rowing that is practiced in the sea, where the main modality is the traineras, crewed by 13 rowers and a coxswain (León Guereño, 2014). A coach's role in sport is very important, and their behaviors are related to athletes' performance and satisfaction (Chelladurai & Riemer, 1998). However, a successful leader in a certain sport does not have to be necessarily good at managing other sport organizations (Smoll & Smith, 2009), which means that each sport is considered unique. Therefore, the aim of this study was to analyse the leadership of traineras' formal coaches. Methods Sixty-six athletes and four coaches participated in this study (33% of the main league). To assess the coaches' leadership, athletes were administered the three versions of the Leadership Scale for Sports (Chelladurai & Saleh, 1980) in its Spanish adaptation (Sánchez Bañuelos, 1996). Both, rowers' preferences and perceptions about their coaches and the coaches' self-perceptions were measured at the end of the season. Results Statistically significant differences were observed between athletes' preferences and perceptions ( $p < .001$ ) in every dimension except in the "initiative margin" dimension ( $p = .827$ ). No significant differences were observed in the six dimensions between coaches' self-perception and rowers' preferences. Two factors showed significant differences between coaches' self-perception and athletes' perception: permeability to opinion ( $p < 0.05$ ) and individual attention ( $p < .001$ ). Discussion Differences found among athletes' preferences, perceptions, and coaches' self-perception are in consonance with previous studies carried out in several team sports (León Guereño, 2014; Sánchez Bañuelos, 1996), so that coaches see themselves with better behaviors than their athletes do, and therefore athletes' needs with reference to the coach are not fulfilled. Our research gathers coaches' leadership data at a certain moment of the year, and at a certain sport level but apart from that very little has been done in relation to how to improve coaches' behaviors in order to achieve excellence, consequently future studies are necessary (Riemer, 2007). References Chelladurai, P. & Riemer, H.A. (1998). *Advances in Sport and Exercise Psychology Measurement* (pp. 227-253), Morgantown, WV: Fitness Information Technology, Inc. Chelladurai, P. & Saleh, S.D. (1980). *Journal of Sport Psychology*, 2, 34-45. León Guereño, P. (2014). (Doctoral dissertation). University of the Basque Country (UPV), San Sebastian. Riemer, H.A. (2007). *Social Psychology in Sport* (pp. 57-73). Champaign, IL, EE.UU.: Human Kinetics. Sánchez Bañuelos, F. (1996). *INFOCOES*, 1(2), 3-16. Smoll, F.L. & Smith, R.E. (2009). Barcelona: INDE. Contact [patxi.leon@deusto.es]

#### THE PENALTY IN FOOTBALL: RELATE TO SUCCEED

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**INTRODUCTION** The penalty kick is an important situation in football. It is commonly accepted that this situation relies on luck. It is easy to admit that strikers need to be fast to be successful. The same goes with the goalkeeper. Some believe that being fast seems to help players to have luck. However, previous studies (e.g. Vicente et al., 2014) showed that there are time relations between players that must be taken into account in football. Players need to be aware of the opponent's actions (stimulus) and possibilities in order to take decisions and make the right choice. The aim of this study was to verify whether a correlation exists between the goalkeeper and the striker in a penalty kick situation in football comparing both players' responses to stimulus. **METHODS** We've used a software (MeSiR1.5) designed to measure the relation between the velocity of the stimulus and the time to respond to it. Test (A) had a goalkeeper (GK) that moved from the center of the goal to each side at different velocities (1 and 3 m/s) randomly. 84 university football players had to press 1 of 4 matching letters in a keyboard, opposite to the goalkeeper displacement (B or V when GK moved right; N or M when GK moved left) for two possible ball velocities (B & N - 50km/h; V & M - 100km/h) for 20 trials. The same players held a second test (B) where a striker (ST) kicked a ball from the penalty kick spot to each side of the goal at different ball velocities ( $\pm 40$ km/h and  $\pm 90$  km/h) randomly and had to press 1 of 4 matching letters according to the ball trajectory (B or V to the left corner; N or M to the right one) for two possible ball velocities perceived (B, N for 40km/h and V, M for 90km/h) for 20 trials. **RESULTS** From the 3360 trials performed from both tests, results showed that players took the right decision in 82% of the situations in A test and in 86% of the situations from test. For the fastest stimulus the average response time in A was 328 milliseconds (ms) and 393ms in B; and for slowest stimulus the time was 375ms in A and 418ms in B. Players choose the faster ball velocity in 73% of the fastest stimulus in A and in 78% of the B situations, and 76% of the times the slowest ball speed in the parallel slowest stimulus in A and 87% in B. **DISCUSSION** Data showed that the stimulus velocity influenced the response

time and the response itself. As the stimulus was faster or slower the response was also faster or slower respectively. The results tend to corroborate previous studies (Vicente et al., 2014) and other ecological studies that we are still carrying out. This suggests that in the penalty in football players should be trained to relate with the opponents being aware that they can influence their actions and their response time in order to take advantage and increase their chances of success. REFERENCES Vicente A., Fernando C., Lopes H., (2014). 19th ECSS, Amsterdam. CONTACT vicente@ubi.pt

### **PLYOMETRIC FOUR WEEK TRAINING BEFORE IN-SEASON TRAINING PROGRAM ON POWER PERFORMANCE IN MALE AMATEUR SOCCER PLAYERS**

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**Introduction** In the past, research studies recently found that practicing plyometric four week training that can be used as an effective way to enhance the power performance in male amateur soccer players (Srikrew, Khaothin and Prachakul, 2014; Khaothin, 2014). The confusion about a difference in short-term plyometric training period for developing power performance before in-season training program in male amateur soccer players has led to this research study. Therefore, the objective of this study was to examine the effect of plyometric four week training on power performance before in-season training program in male amateur soccer players. **Methods** The participants were male amateur soccer players of the Faculty of Sports Science Team, Kasetsart University, Nakhon Pathom, Thailand, and in the period before participating in-season training program. All participants were randomly assignments into two groups in a plyometric training group (n=10) and a control group (n=10). Participants were tested in power performance by the squat jump and countermovement jump test before beginning participates in plyometric training. After all participants completed four weeks plyometric training period and were retested. **Results** The results of this study show that there were no significant improvements in power performance test by the squat jump and countermovement jump test between plyometric training and control groups. And there were no significant differences in the pre and post plyometric training before in-season training program in male amateur soccer players. **Discussion** From data obtained in this study not supported the past research studies found that plyometric four week training can result is sufficient enough to show improvements of power performance before in-season training program in male amateur soccer players (Srikrew, Khaothin and Prachakul, 2014; Khaothin, 2014). These two studies suggested that power performance increases by four weeks plyometric training period before in-season training program is sufficient enough for the development of muscle strength is considered to be the basic quality that influences muscular power (Schmidtbleicher, 1992). This will be developed during the first 3-4 weeks of training periods by neurological adaptations from the program (Pearson and Gordon, 2000). References Khaothin T. (2014). 5th ICSES Proceeding, 47. Pearson K, Gordon J. (2000). Principles of Neural Science, 713-736. Schmidtbleicher, (1992). Strength and Power in Sports, 169-179. Wisarut S, Khaothin T, Prachakul W. (2014). Journal of Sports Science and Technology, 1, 40-45.

### **KEY DRIVERS OF CUSTOMER EXPERIENCE IN THE PLAYERS OF PREMIER LEAGUE FOOTBALL CLUBS**

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**Introduction:** Organizations to improve quality of service and increase competitive power by identifying the forces driving the customer experience will enable, in every time interact of customers with the organization ,to create a rewarding experience and with managing this experience will present a better product or service(Moharamzadeh, Akbari,2013). Customer experience, however, is a wide term, and encompasses both expectations to and perception of the customers. Better customer experiences will lead to better satisfaction and to an increase in loyalty (Klaus et al 2012). A good customer experience was also believed to create competitive advantage (Johnston, Kong , 2011).The aim of this study was to identify the key driving customer experience in the players of Premier League Football Clubs. **Method:** 236 football players in the Premier League clubs participated in this study as an example. The standardized questionnaire of customer experience by Sandersen and Lian (2011) was used (Sandersen, Lian, 2011). The validity of the questionnaire was confirmed by experts and the internal consistency of the questionnaire in a pilot study gain  $r = 0/88$ , factor analysis method was used to confirm of each factors. **Result:** Results revealed a total of seven operating flexibility, knowledge and personal contact, understanding customer needs, follow up, promise fulfillment and responsiveness was explained % 87/5 of total variance of customer experience. Cronbach's alpha for the seven factors gains respectively, 0.92, 0.87, 0.89, 0.86, 0.88, 0.87, and 0.85. **Conclusion:** Results showed that a good Customer Experience can be created through flexibility, knowledge and personal contact, understanding customer needs, follow up, promise fulfillment and responsiveness by club managers in football players .club managers can use of customer experience as a competitive strategy. Build a better experience for players makes feel worthy and this feel will lead to loyalty (Tsiros et al, 2006).

### **THE RELATIONSHIP BETWEEN DIFFERENT HITTING REGIONS ON A TENNIS RACQUET AND ACCURACY ON THE COURT-THE COURT**

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**Introduction** Contact point (CP) has been known as an important factor for making a better stroke in both forehand and backhand in tennis. However, effect of different hitting regions on the racquet has been controversial. Aim of this study is to examine the relationship between different hitting regions of a tennis racquet and hitting accuracy on the tennis court. **Methods** This is a pilot study including 10 professional level male tennis players (age:  $20.9 \pm 3.41$  years, training experience:  $9.30 \pm 2.31$  years, weekly training volume:  $8.20 \pm 1.75$  hours, height:  $1.80 \pm 0.04$  m, mass:  $75.7 \pm 5.2$  kg). A  $5.50 \times 2.05$  m area on backhand side (BHS) and forehand side (FHS) was drawn on the court for accuracy measurements. A ball machine (Spinfire Pro II®) was placed on the baseline for standardized ball delivery. Players completed a 5 set of 10 forehand shots to BHS and FHS, completing 100 forehand shots in total (50 BHS / 50 FHS). Racquet head was divided into 5 different regions for CP assessment: Region 1: middle (R1), Region 2: lower mid (R2), Region 3: mid left (R3), Region 4: upper mid (R4) and Region 5: mid right (R5). Data collection was performed with Babolat Play Pure Drive® tennis racquet. **Results** No significant difference was found in maximal racquet head speed (MRS), average racquet head speed (ARS), number of shot on target, number of shot performed in each of five different regions of racquet between shots directed to different targets ( $p > 0.05$ ). Number of shot on FHS target was negatively correlated with number of shot performed with R2 and R3 of racquet ( $p < 0.002$ ), whereas positively correlated with that in R4 ( $p < 0.001$ ). However, number of shot on BHS target was negatively correlated with only number of shot performed with R2 of racquet ( $p = 0.039$ ). In general, number of total shot on target was negatively correlated with number of shot performed with R2 and R3

( $p < 0.02$ ), whereas positively correlated with R4 ( $p = 0.03$ ) Discussion Although for many years, middle of the racquet head (R1) was taught as the sweet spot for better control, feel and produces less vibration in the joints (Carello C. et al. 1999, Haake S. 1996, Hatze H. 1994) according to the results of this study, for total shots; accuracy increased with CP on R4 but not on R1. For FHS, if CP was on R1 and R4, accuracy increased. if CP was R2 and R3, accuracy decreased. On the BHS however, accuracy decreased if only CP was on R2 and there was no positive correlation between different regions and accuracy. Although these results are preliminary, this might mean, as long as ARS stays similar, accuracy might not be affected with CP for BHS but not for FHS. References Carello C., Thuot S., Anderson K., Turvey M., (1999) Perceiving the sweet spot, Perception 28(3): 307-20 Hatze H. (1994) Impact Probability Distribution, Sweet Spot and the Concept of an Effective Power Region in Tennis Rackets, J. Appl. Biomech. 10, 43–50 Haake, S. (1996) Engineering of Sport, 80– 82, Taylor & Francis, New York Contact Assf. Prof. Dr. Ozan Atalag ozanatalag@gmail.com

## Oral presentations

### OP-SH02 Sport Psychology and Motor/Cognitive Function

#### A THREE-WAVE CROSS LAGGED PANEL TEST OF SELF-DETERMINATION THEORY'S PSYCHOLOGICAL NEEDS-MEDIATED MODEL OF ENGAGEMENT AND DISAFFECTION IN YOUTH SPORT

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Engagement in youth sport provides an important source of physical, psychological and social health for adolescents. Adopting self-determination theory (SDT), research has found support for a mediation model whereby the motivational style (viz. autonomy support and interpersonal control) of coaches predicts athletes' engagement and disaffection via the satisfaction of three psychological needs; autonomy, competence and relatedness. The current study extends this research by examining SDT's needs-mediated model longitudinally. A three-wave cross-lagged panel design was adopted in which 252 adolescent youth sports participants (Mage = 12.98; female  $n = 67$ ) completed measures at the start, middle and end of a competitive youth soccer season. Analyses revealed that the associations between the two coach motivational styles and adolescent engagement in soccer were mediated by psychological need satisfaction. In addition, there was evidence of reciprocal causation between psychological need satisfaction and engagement over time. In an important extension to extant research, this study supports the temporal assumptions underpinning SDT's needs-mediated model and evidences the dialectical interplay of psychological needs and engagement.

#### REFLECTION AND BALL CONTROL IN YOUTH BASKETBALL PLAYERS FOR DIFFERENT POSITIONS

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Introduction Reflection and ball control are important skills for performing at elite level in basketball<sup>1,2</sup>. However, their importance for reaching elite level might differ between positions (guard, forward, center). This study examines differences between positions regarding the development of reflection and ball control and for the importance of both skills in reaching elite level at age >20 years. Method Talented male basketball players ( $n=73$ ; age range 13-20) completed the self-regulation of learning self-report scale to measure reflection (range 1-5), and the STARtest to measure ball control from 2008-2012. Pearson correlations were calculated between age, reflection and ball control to investigate the development of both skills and their interdependence. Differences between correlations were calculated with Z-scores. A multivariate analysis of variance is performed for a subgroup with players of >20 years in 2014 to examine differences between players who reached elite level ( $n=11$ ) and non-elite level of performance ( $n=18$ ). Performance level and position were added as fixed factors, and reflection and ball control as dependent variables. Results Reflection ( $4.03 \pm .54$ ) did not correlate with age in either position ( $p > .05$ ). Regarding ball control, players improved their performances over time, with the strongest development for guards ( $r = .65$ ). A higher score on reflection related to better ball control in guards ( $r = .19$ ) and forwards ( $r = .18$ ) in contrast to centers ( $r = .34$ ). Regardless of position, players who reached elite level at age >20 scored higher on reflection ( $4.29 \pm .29$ ) during their adolescent years compared to players who reached non-elite level ( $4.04 \pm .31$ ;  $p = .03$ ). For ball control, no differences were found between elite ( $19.62 \pm 1.14s$ ) and non-elite ( $19.67 \pm 1.02s$ ). However, positional differences were found, in favour of guards and forwards ( $p < .01$ ). Discussion This study showed no positional differences for the development of reflection, while guards showed the strongest development regarding ball control. For reaching the elite level, very good reflective skills are important regardless of position. These reflective skills are thought to be important for guards and forwards to improve their ball control performances, while centers use them to improve skills that are more important for their position. This suggests that players use position-generic reflective skills for improving position-specific skills. References 1Torres-Unda J, Zarrazquin I, Gil J, Ruiz F, Irazusta A, Kortajarena M, Seco J, Irazusta J. (2013). J Sports Sci, 31(2), 196-203. 2Zimmerman BJ. (2006). The Cambridge handbook of expertise and expert performance, 705-722. Contact s.c.m.te.wierike@umcg.nl

#### BREATH SLOWER, BE SMARTER? THE EFFECTS OF SLOW PACED BREATHING ON COGNITIVE EXECUTIVE FUNCTIONING

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Slow paced breathing has been found to increase cardiac vagal tone, creating a resonance state in the cardiovascular system when the individual breathes at 6 cpm. According to the neurovisceral integration model, cardiac vagal tone is positively associated with executive performance (Thayer, Hansen, Saus-Rose, & Johnsen, 2009). However, it is still unknown whether an increase in cardiac vagal tone provoked by slow paced breathing would result in an increase of executive performance. Moreover, the most optimal inhalation/exhalation ratio and the duration of the effects of slow paced breathing are still unknown. Therefore the aim of this research project was twofold: first to clarify the most optimal way to realize slow paced breathing as well as the duration of its effects, and second to investigate its influence on executive performance. This research project comprised of five experiments. Cardiac vagal tone was assessed through heart rate variability and more specifically with the root mean square of the successive differences (RMSSD). Respiratory rate was controlled for in all analyses. The first two experiments aimed to investigate the parameters of slow paced breathing and the duration of its effects. Experiment 1 ( $N=63$ ) showed that the best ratio was obtained with longer exhalation and shorter inhalation, provok-

ing a higher activation of the vagal brake. Experiment 2 (N = 15) showed that the effects of slow paced breathing on cardiac vagal tone lasted at least 1h, with a higher increase in comparison to a video control condition. Regarding the second aim, we investigated the effects of slow paced breathing on the three core executive functions (Diamond, 2012): inhibition (experiment 3), working memory (experiment 4), and cognitive flexibility (experiment 5). Based on similar within-subject designs (N = 30 for experiments 3, 4, 5), we found that performance on all executive functions increased after slow paced breathing in comparison to a video control condition, and RMSSD was found to mediate this increase. In summary, this research project showed that slow paced breathing can increase executive performance through vagal tone increase, based on the most optimal inhalation/exhalation ratio, and that those effects may last at least for 1h. Given the protective properties of a higher vagal tone for health and against stress (Thayer et al., 2009), slow paced breathing may play a very important role regarding health on a larger society scale. Diamond, A. (2012). Executive Functions. *Annu Rev Psychol*. doi: 10.1146/annurev-psych-113011-143750 Thayer, J. F., Hansen, A. L., Saus-Rose, E., & Johnsen, B. H. (2009). Heart rate variability, prefrontal neural function, and cognitive performance: the neurovisceral integration perspective on self-regulation, adaptation, and health. *Annals of Behavioral Medicine*, 37, 141-153. doi: 10.1007/s12160-009-9101-z

## THE NUMBER OF COMPETITORS AFFECTS PACING AND PERFORMANCE IN SHORT-TRACK SPEED SKATING COMPETITIONS

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THE NUMBER OF COMPETITORS AFFECTS PACING AND PERFORMANCE IN SHORT-TRACK SPEED SKATING COMPETITIONS Introduction The presence of opponents is inextricably linked to sports performance. However, the required actions for an athlete to outperform the others depend on the way a competition is structured (Stanne et al., 1999). In this perspective, the number of competitors in a race might influence pacing behaviour and performance, as one seems relatively more dependent on the actions of the opponents with a lower number of competitors. The present study aimed to analyze how the number of competitors influenced pacing and tactics in short-track speed skating, a sport setting in which athletes directly compete within the same race. Methods Finishing and split times, as well as start, intermediate and final rankings of 500m, 1000m, and 1500m races were collected from short-track speed skating World Cups, European/World Championships, and the Olympic Games during the season 2012/13 (n=1141 races) and 2013/14 (n=973 races). To explore if pacing behaviour differed depending on the number of competitors, lap and finishing times were analyzed using a MANCOVA (P<0.05) in which the number of competitors was the independent variable and stage of competition, sex, and final-ranking were added as covariates. To explore if tactical positioning differed depending on the number of competitors, intermediate rankings at a particular lap were correlated with the final rankings for each number of competitors using Kendall's Tau b correlations. Cohen's Q was used to compare the correlations for each number of competitors (with Q>.30: medium or large effect). Results Finishing times (t) were slower when the number of competitors (nc) was lower for the 500m (t=44.65±1.7s, nc=3; t=43.71±1.7s, nc=4; t=43.61±1.7s, nc=5; P=.002), 1000m (t=93.79±3.4s, nc=3; t=91.06±3.5s, nc=4; t=90.62±3.4s, nc=5; P<.001) and 1500m (t=160.4±12.5s, nc=4; t=148.3±7.6s, nc=5; t=145.5±6.1s, nc=6; t=142.3±5.0s, nc=7; P<.001). For the 1000m and 1500m, especially the beginning stages of a race were slower for a lower compared to a higher nc. In addition, the first part of a race showed lower correlations between intermediate and final rankings for a lower compared to a higher nc (e.g. Q>.35 for lap 1-6 of 1000m when comparing nc=3 vs nc=5). Discussion A lower number of competing opponents led to slower lap times in the beginning stages of the race and slower final times. Moreover, higher final-ranked athletes positioned themselves in the foremost positions earlier in the race if more opponents were competing. In conclusion, the number of competitors seems to influence pacing, tactics and performance in a sport involving a direct form of competition. References Stanne M, Johnson D, Johnson R (1999) *Psychol Bull*, 125(1), 133-154 Contact fjhett@essex.ac.uk

## TO IMPROVE OR NOT TO IMPROVE; THE PSYCHOLOGICAL PROFILE OF ELITE YOUTH SPEED SKATERS

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Introduction Improving performance is essential for elite youth athletes to eventually reach the top. Why some keep improving and others do not, remains hard to explain. This study investigates for three age categories whether psychological characteristics associated with learning (goal orientation, motivation and self-regulation) can distinguish between improving and non-improving elite youth speed skaters on the 1500m. Methods At baseline Dutch elite youth speed skaters (international top) in the age categories 13-14 (n=23), 15-16 (n=91) and 17-18 year (n=40) completed the Task and Ego Orientation in Sport Questionnaire (TEOSQ), the sport motivation scale (intrinsic and extrinsic motivation), and the self-regulated learning – self-report scale (planning, self-monitoring, evaluation, reflection, effort and self-efficacy). Performance was defined as the time the season best time is above the world record (WR) of the corresponding gender (male 101.04s, female 111.79s) at baseline and two years later. Based on two year performance improvement, speed skaters were divided into improvers (improve > 5%, n=85) and non-improvers (decline > 5%, n=43). (Multivariate) analysis of variance was used to find differences between improvers and non-improvers on baseline performance and the psychological variables. Results There was no difference in baseline performance between improvers and non-improvers for all age categories (above WR: 13-14 year 26.6±5.2s, 15-16 year 17.6±4.0s, 17-18 year 14.15±4.4s). At 13-14 year TEOSQ (range 1-5) distinguishes improvers (n=16) from non-improvers (n=6; p<.05), with improvers scoring a combination of higher ego orientation (4.2±.5 vs 3.6±.7) and somewhat lower task orientation (4.3±.5 vs 4.6±.4). At 15-16 year no differences were found. At 17-18 year improvers (n=23) scored higher than non-improvers (n=12) on self-efficacy (3.3±.4 vs 2.8±.5, range 1-4; p<.05). Discussion To improve or not to improve is not dependent on baseline performance for elite youth speed skaters. Both improvers and non-improvers scored high on all psychological variables compared to previous literature (Jonker et al., 2010; Elferink-Gemser et al., in press), indicating very good psychological characteristics relevant for learning. Nevertheless, it appears important for elite youth speed skaters to focus on winning at age 13-14, and to believe in their own ability to complete tasks and reach goals at age 17-18 to improve 1500m performance the consecutive two years. References Jonker L, Elferink-Gemser MT, Visscher C. (2010). *J Sports Sci*, 28, 901-908 Elferink-Gemser MT, De Roos I, Torenbeek M, Fokkema T, Jonker L, Visscher C. (in press). *Int J Sports Psychol* Contact i.k.stoter@umcg.nl

**ASSESSING PERSONAL TALENT DETERMINANTS IN YOUNG RACQUET SPORT PLAYERS: A SYSTEMATIC REVIEW**

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Introduction Selecting and monitoring young racquet sport players in the context of talent developmental programmes is extremely difficult. Since junior performances have little predictive value for future success, other solutions are sought to assess a young player's potential. The objectives of this systematic review are 1.) to provide an overview of instruments measuring personal talent determinants of young players in racquet sports, and 2.) to evaluate these instruments regarding their validity for talent development. Methods Electronic searches were conducted in PubMed, PsychINFO, Web of Knowledge, ScienceDirect, and SPORTDiscus (1990-31th March 2014). Search terms represented tennis, table tennis, badminton, and squash, the concept of talent, methods of testing, and children. An overall methodological quality check of the included articles was conducted (Law et al., 1998). All instruments assessing personal talent determinants, that were found in the articles, were classified using Gagné's Differentiated Model of Giftedness and Talent 2.0 (2010). Instruments' validity for talent developmental purposes was checked by their capacity to discriminate between elite and non elite players, to predict future performance, and to provide directions for talent development. The specific level of evidence regarding validity was evaluated using the COnsensus-based Standards for the selection of health Measurement Instruments checklist (Mokkink et al., 2010). Results Thirty articles with information regarding over 100 instruments were included. Validity evaluation showed that instruments focusing on intellectual and perceptual abilities, and coordinative skills discriminate elite players from others and/or are related to current performance, but their predictive validity is not confirmed. There is moderate evidence that the assessments of mental and goal-management skills predict future performance. Data on instruments measuring physical characteristics prohibit a conclusion due to conflicting findings. Discussion This systematic review yielded an ambiguous endpoint. The value of instruments as part of talent development programmes depend on the context and the player's developmental phase. The lack of longitudinal studies preclude verification of the instrument's capacity to forecast future performance. Future research should focus on instruments assessing multidimensional talent determinants, and their predictive value in longitudinal designs. References Gagné (2010). *High Ability Studies*, 21, 81-99. Law et al. (1998). Hamilton, MacMaster University. Mokkink et al. (2010). *BMC Med Res Methodol*, 10, 22.

**Oral presentations****OP-SH03 Sport management (Sustainability and Sport events)****SPECTACLE MEETS SUSTAINABILITY: THE RELATIONSHIP BETWEEN EVENTS AND SPORT-FOR-DEVELOPMENT PROGRAMS**

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Sport-for-development (SFD) programs are seen as promising vehicles for improved communication and celebration within and between communities (Sugden, 2010). Particularly in disadvantaged community settings, government agencies, aid organizations and NGOs have been implementing SFD projects for several years. Most of these initiatives also include special events such as cultural festivals, sport tournaments and educational conferences as part of the overall program portfolio. However, there is little specific understanding of the role and effectiveness of these initiatives in contributing to overall community development. The belief that events have a role to play in SFD stems from arguments around event leverage and ripple effects. First, to achieve leverage, SFD organizers need to move beyond the planning of immediate impacts and instead focus on strategic paths to maximize sustainable outcomes for host communities (Schulenkorf & Edwards 2012). Second, Sugden's (2010) Ripple Effect model suggests that just like a stone dropped into a still pool of water, a community intervention has its strongest impact on those directly involved in a program or event. However, community activities may also influence related stakeholders (e.g. families, communities, policymakers etc.) as the ripples will wash over the shoes of those who walk in the corridors of power. Our study investigated the contribution of special events within the football-based Just Play initiative which promotes physical activity, healthy living and community involvement across ten Pacific Islands. The study builds on 38 interviews and three focus group discussions with Just Play stakeholders from Vanuatu, Samoa and the Cook Islands. We found that one-off 'highlight events' have the ability to play an important role within the context of ongoing, regularized SFD programs; they can provide much needed excitement, animation, enthusiasm and vibrancy. These findings can also be linked to the different dimensions of social capital (see Putnam 2000); they can renew interest among local participants (bonding), but also arouse interest among those who have yet to engage (bridging and linking). In other words, regular programs are able to deepen existing relationships and networks, while 'highlight events' allow for the widening of participation and program scope. References Putnam, R. D. (2000). *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon & Schuster. Schulenkorf, N., & Edwards, D. (2012). Maximizing Positive Social Impacts: Strategies for Sustaining and Leveraging the Benefits of Intercommunity Sport Events in Divided Societies. *Journal of Sport Management*, 26(5), 379-390. Sugden, J. (2010). Critical left-realism and sport interventions in divided societies. *International Review for the Sociology of Sport*, 45(3), 258-272

**FROM LONDON TO RIO: CAN SUSTAINABILITY BE SUSTAINED?**

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In 1996 the International Olympic Committee (IOC) amended its charter to recognize the environment as the third pillar of "Olympism," joining sport and culture (London Strives). A key element of this pillar is sustainability, and the Olympic Movement's efforts to set new standards at large sports events and beyond (Sustainability). While all Olympic host cities since 1996 did, to varying success, address environmental issues, it was not until the 2012 Olympic and Paralympic Games in London that the concept of sustainability was at the forefront (London Strives). It was the ambition of the British government for the 2012 Games to be genuinely sustainable; it believed that "the Olympic Park would be a blueprint for sustainable living, inspiring individuals to live more sustainably as a result of the Games" (UK). Following the completion of the 2012 Olympics and Paralympics, the Commission for a Sustainable London 2012 (CSL2012) said the Games had "raised the bar for sustainability" and was, in fact, the most sustainable Olympics Games ever held (London 2012). We now

must look forward to the 2016 Olympic and Paralympic Games in Rio de Janeiro. Rio is planning even greater levels of sustainability for the 2016 Games, including higher levels of renewable energy, extensive bike paths connecting Olympic venues, and a goal of 100 percent biodiesel fuel (Report). However, there is now skepticism that this will occur, due in part to a lack of coordination and communication among those charged with these tasks (Rio). Will Rio be able to match or surpass the success of London? Or will the London legacy of sustainability both during and after the Games be a singular success? In this study the author will examine what role the success of the 2012 London Games in upholding the third pillar of Olympism will have on the 2016 Rio de Janeiro Games. References "London 2012 'most sustainable' Olympics, watchdog says." BBC News. 14 November 2012. Retrieved February 12, 2015. <http://www.bbc.com/news/uk-england-london-20334658>. "London Strives for Zero Waste Summer Olympics 2012." Sullivan, Dan. *BioCycle*. Vol.53, Issue 9. September 2012. Pages 32-34. Report Traces Sustainable Development of Olympic Games." Professional Services Close-up. June 12, 2012. Retrieved February 5, 2015. <http://search.proquest.com.ezproxy.saintleo.edu/printviewfile?accountid=4870>. "Rio de Janeiro seeks transport overhaul for 2016 Olympics." Murray, Sarah. FT.com. June 24, 2013. Retrieved February 5, 2015. <http://search.proquest.com.ezproxy.saintleo.edu/printviewfile?accountid=4870>. Sustainability. (n.d.). Retrieved February 5, 2015. <http://www.olympic.org/sustainability>. "UK Government: Environment Minister Dan Norris announces GBP1m funding for the third sector to inspire sustainable living as part of the government's legacy action plan for the London 2012 Olympic Games and Paralympic Games." Anonymous. M2 Presswire [Coventry]. 29 March 2010.

### ACADEMIC RESEARCH COLLABORATION FOR RISK MANAGEMENT IN SPORTS EVENTS

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Long distance races are becoming increasingly popular, probably because of the awareness regarding the benefits of physical activities. However, risk management in these events is still not fully explored, and its relationship with researches in the physiology area is still non-existing. Therefore, the objective of this study was to analyze the influence of the participation in academic researches for risk management in sports events. Methods: 104 male runners, aged  $34.53 \pm 8.01$ , participating in two research projects in the area of physical exercise physiology with medical evaluation, performed with half marathons and marathon, who answered a self-administered questionnaire, 24 hours prior to the race in which they were to participate. Results: of the runners evaluated, 60.58% have completed higher level of education. Regarding modifiable risk factors, such as diabetes and dyslipidemia, none of the runners presented these pathologies since this was a criterion for being included in the study; however, 1.92% (2) were smokers and 2.88% (3) were hypertensive. Regarding not modifiable risk factors, 52.88% had family history of hypertension, 40.38% of diabetes, and 21.15% of dyslipidemia. Considering this scenario, where there is a great number of risk factors, only 77% undergo periodic physical evaluations and only 18.27% is assisted by a sports advisory team with  $5.51 \pm 4.84$  years of experience in training, being that all runners participate in sports events and have participated in at least one marathon in their sports life. Conclusion: We may conclude that people who participate in long duration sports events are exposed to high risks. Nonetheless, a large number of runners do not undergo periodic medical evaluations and do not receive assistance from sports advisory teams, further increasing the risk when participating in long duration sports events such as marathons and half-marathons. We still do not know if the large number of runners not assisted by sports advisory teams found in academic researches results from concern regarding controlling their risk factors, since they do not have a sports advisory team, or if those who are assisted by sports advisory teams do not participate in the researches because their coach does not authorize them to do so. Thus, participation in academic researches contributes to a thorough evaluation and damage control regarding the runner's participation in this modality of sports events and may be better explored for more effective risk management.

### ON THE PERIPHERY: NEW PERSPECTIVES ON THE OLYMPIC AND PARALYMPIC MOVEMENT

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Introduction Major sporting festivals, such as the Olympic Games, continue to change both at the core and the periphery. Changes at the core include the inclusion of new sports and nations in the Games. How the Games are mediated, consumed and interpreted and what happens on the fringe of the Games represent some examples of changes on the periphery. This paper explores two topics which fall within this 'periphery' category. One new concept is the emergence of 'Olympic Houses' organised by various NOCs during the time of the Games. This comparative investigation of several nations traces the historical background and the motives behind their establishment, structure, sponsorship and internal evaluations. The second part of the paper is an examination of the early Paralympic Games, initially a very peripheral event to the Olympic Games. Methods Primary and secondary written sources associated with these topics were examined. Extensive use was made of interviews of key Olympic House staff, Olympic athletes, their families, sponsors of National Olympic Committees and Paralympic athletes and officials. Participant observation techniques were employed with the authors attending the 2008 Beijing Summer Olympic Games, the 2010 Vancouver Olympic Winter Games and the 2012 London Summer Olympic Games. Results Olympic Houses were found to be a relatively new concept and are primarily the domain of the more established and successful Olympic nations, although the format, programs and services of Olympic Houses varied considerably. It was found that most Olympic Houses served a very valuable role of "distraction management" for Olympic athletes. They also were a means of giving a larger profile to sponsors of National Olympic Committees as well as a "home away from home" for key individuals associated with an Olympic Team. Based on recent interviews with some of the leading athletes from the 1960 and 1964 Paralympic Games, some fresh historical perspectives on the pioneers of disability sport are offered as this major sports event eventually transitioned from a very peripheral part of the Olympics to a more formalised status. Discussion It appears that Olympic Houses are here to stay as part of the overall Olympic movement. Although they are still very much on the periphery, the International Olympic Committee is only interested at this point in time in monitoring not governing this area. In contrast, the Paralympic Games have altered their status and moved from a peripheral role to very much being an integral part of the Olympic Games. References Baka, R. and Hess, R. (eds.) *On the Periphery: New Perspectives on the Olympic Movement* Walla Walla Press, Sydney, 2013. Contact Richard.Baka@vu.edu.au and Robert.Hess@vu.edu.au

## Oral presentations

### OP-PM19 Physiology: Fatigue, Muscle damage & repair

#### CONTRALATERAL PROTECTIVE EFFECT CONFERRED BY LOW-INTENSITY ECCENTRIC EXERCISE AGAINST MAXIMAL ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE

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**Introduction** Eccentric exercise-induced muscle damage is reduced by performing non-damaging eccentric exercise within 2 weeks prior to the damaging exercise [1]. Some studies showed that the magnitude of muscle damage induced by maximal eccentric contractions (MaxEC) of the elbow flexors (EF) was smaller for the arm that was used in the second than the first bout, which is referred to as the contralateral repeated bout effect (CL-RBE) [2,3]. However, it is not known whether non-damaging eccentric contractions can provide any preconditioning effect on the contralateral arm. This study investigated whether low-intensity eccentric contractions would reduce the magnitude of muscle damage after MaxEC performed by opposite arm within 2 weeks later. **Methods** Seventy-eight untrained young men were assigned (n=13/group) to five preconditioning groups that performed 5 sets of 6 low-intensity eccentric contractions with a load equivalent to 10% of maximal voluntary isometric contraction strength (10%EC) for the first bout, followed 1 day (1d), 2 days (2d), 1 week (1w), 2 weeks (2w) or 3 weeks (3w) by 5 sets of 6 MaxEC of the other arm, or one control group that performed MaxEC only. Changes in maximal voluntary concentric contraction torque, range of motion, upper arm circumference, muscle soreness, plasma creatine kinase activity and myoglobin concentration and B-mode ultrasound echo-intensity of the exercised muscles after MaxEC were compared among the groups by a two-way repeated measures ANOVA. **Results** 10%EC did not change any variables. Changes in all dependent variables after MaxEC were significantly ( $P < 0.05$ ) smaller for the 1d, 2d and 1w groups than the control group, without significant difference between the 1d and 2d groups, but with significant differences between 1d/2d and 1w groups. Changes in the variables were not significantly different among the 2w, 3w and control groups, except for muscle soreness showing significantly ( $P < 0.05$ ) smaller changes for the 2w/3w groups than the control group. **Discussion** These results showed that 10%EC conferred potent protective effect on the contralateral arm to attenuate the magnitude of muscle damage, and the effect lasted for 1 week but was reduced between 2 days and 1 week. When compared with the effect found for the ipsilateral arm in the previous study [1], the contralateral protective effect appears to be smaller and shorter-lived, but was still effective for substantially reducing muscle damage. **References** 1) Chen et al. (2012) *Eur J Appl Physiol*, 112, 555-65. 2) Starbuck & Eston (2012) *Eur J Appl Physiol*, 112, 1005-13. 3) Newton et al. (2013) *J Sci Med Sport*, 16, 166-71. **Contact:** tcchen@ntnu.edu.tw

#### EFFECT OF COMPRESSION GARMENTS ON RECOVERY OF EXERCISE PERFORMANCE FOLLOWING DOWNHILL RUNNING

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**Introduction** Growing evidences suggest that wearing a compression garment (CG) promotes recovery after strenuous resistance exercise (Kraemer et al. 2010; Goto and Morishima, 2014). However, the effect of CG on recovery following endurance exercise has not been fully understood so far. **Purpose** The present study was designed to investigate effect of wearing lower body CG for 24h on time course of changes of exercise performance following downhill running. **Method** Nine males conducted 30 min downhill (gradient: -10%) running at 70% of  $VO_{2max}$  in two trials, wearing either a CG or a placebo garment (CON) for 24 h after exercise. Time courses of changes of height of counter movement jump (CMJ), running economy, scores of muscle soreness and subjective fatigue, and circumferences of upper and lower limb muscles were compared between the trials. **Results** No significant difference was observed in CMJ height between the trials at any time points ( $P > 0.05$ ). However, in the CG trial, CMJ height recovered to pre-exercise value at 24h after the exercise, whereas not in the CON trial ( $P < 0.05$  vs. pre-exercise value). Running economy at 70, 80 and 90% of  $VO_{2max}$  did not differ significantly between the trials at 24h after exercise. No significant difference was observed in time course changes of muscle soreness, subjective fatigue or muscle circumferences between the trials throughout post-exercise periods. **Discussion** To our knowledge, this is the first study to examine the efficacy of CG on recovery following downhill running. In the present study, we were not able to observe significant interaction (trial  $\times$  time) or main effect (trial) for the changes in CMJ height, running economy, or scores of muscle soreness and subjective fatigue. However, the CG trial showed faster recovery of CMJ height at 24h after the exercise, while the CMJ height remained significantly lower in the CON trial. The mechanism underlying promotion of recovery remains unclear, but augmented venous return of lower limbs by the use of CG for 24 h might be involved. **Conclusion** Wearing CG following downhill running did not facilitate the recoveries of running economy or muscle soreness. However, the use of CG might be beneficial for promotion of recovery of maximal power output for lower limbs. **Reference** Goto K, Morishima T. (2014) *Med Sci Sports Exerc.* 46(12):2265-2270 Kraemer WJ, Flanagan SD, Comstock BA, Fragala MS, Earp JE, Dunn-Lewis C, Ho JY, Thomas GA, Solomon-Hill G, Penwell ZR, Powell MD, Wolf MR, Volek JS, Denegar CR, Maresh CM. (2010) *J Strength Cond Res.* 24(3):804-14 **Contact:** sh0019hs@ed.ritsumei.ac.jp

#### TEN MAXIMAL ISOMETRIC CONTRACTIONS DO NOT ATTENUATE DOWNHILL RUNNING-INDUCED MUSCLE DAMAGE AND EFFICIENCY LOSS

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**Introduction** Downhill running-induced muscle damage (EIMD) has been proven to compromise strength production, running efficiency (RE) and promote muscle soreness and swelling. Recent evidence showed that, when performed prior to an eccentric damaging bout, maximal isometric contractions (MIC) attenuate EIMD symptoms in untrained populations. The aim of this study was to investigate if performing 10 MIC before a downhill running bout (DRB) would attenuate EIMD and, most importantly, decreases in RE. **Methods** Twenty untrained male volunteers were randomly assigned to either a control (CON) or an experimental (ISO) group. All participants ran downhill (-15%) for 30 minutes at 70% of their maximal oxygen consumption. Volunteers in the ISO group performed 10 MIC in a leg press machine 2 days before the DRB while those in the CON remained inactive during this period. EIMD [isometric peak torque (IPT), perceived muscle soreness (SOR), thigh circumference (CIR)] and RE (oxygen consumption, minute ventilation, lactate concentration, perceived exertion)



parameters were assessed before, immediately after and 1-4 days after the DRB. Results Significant decreases in IPT were identified immediately (CON: 22% vs. ISO: 20%) and 1 day (CON: 23.1% vs. ISO: 20.1%) after the DRB, with no differences between groups. SOR increased equally for both groups 1 (CON: 7.3 cm vs. ISO: 8.1 cm) and 2 (CON: 7.6 cm vs. ISO: 9.1 cm) days after the DRB. CIR remained unaltered throughout the whole experiment. All RE parameters increased significantly immediately and 1 day after the DRB, with no difference between groups. Discussion Increases in EIMD and RE markers for the CON group of the present study were similar to those reported in previous studies, with faster recovery. However, no significant interactions were found between groups. This indicates that performing MIC previous to a DRB does not attenuate EIMD, which has been described to compromise RE. To our knowledge, no previous studies investigated the use of MIC as a protective strategy against EIMD in the lower limbs. It has been reported that lower limb muscles are less susceptible to EIMD than their upper limbs counterparts. Moreover, the repeated bout effect conferred by eccentric contractions is more accentuated in upper than in lower limbs muscles. Since the protection conferred by MIC is less effective than that conferred by eccentric contractions, we suggest that this strategy might not be potent enough for muscle groups that frequently perform eccentric contractions and are, therefore, already well protected against EIMD. Finally, RE parameters were altered at the same time points as IPT, which corroborates to the knowledge that muscle strength is related to RE.

## THE ROLE OF BRAIN-DERIVED NEUROTROPHIC FACTOR IN THE EXERCISE-INDUCED SKELETAL MUSCLE INJURY AND REPAIR

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**Introduction** Skeletal muscle has been found to be a source of brain-derived neurotrophic factor (BDNF) outside nervous system. However, its role in the skeletal muscle has not been fully elucidated. Here we studied the exercise-induced BDNF expression in the rats in order to explore the possible role of BDNF in skeletal muscle injury and regeneration. **Methods** Sprague-dawley rats were subjected to downhill running at 17m/min for 90 minutes. We first evaluated skeletal muscle injury by histology and serum creatine kinase (CK) activity and tested skeletal muscle regeneration by the expression of MyoD in satellite cells through immunohistochemistry. Then, the level of BDNF was measured in serum and soleus by ELISA and real time RT-PCR, respectively. Finally, we studied the TrkB expression through immunohistochemistry and real time RT-PCR and its phosphorylation through immunohistochemistry in the soleus. T-test was employed to compare the difference among distinct groups using SPSS software and  $p < 0.05$  was considered statistically significant. **Results** Besides skeletal muscle fiber disruption, a temporally increased serum CK activity was found following downhill running, indicating the skeletal muscle injury. In addition, we observed the expression of MyoD, the molecular marker of satellite cell activation, in the soleus the first day following the downhill running, showing the regeneration process. Elevated serum BDNF level was present from day 2 and maintained for two weeks in the serum following the downhill running. Similarly, enhanced mRNA level of BDNF was found in the soleus in response to the exercise. In addition, we observed that TrkB, the high affinity receptor of BDNF, is located on the membrane of skeletal muscle cells and immune cells, however its mRNA level didn't show significant alterations following the downhill running. Surprisingly, phosphorylation of TrkB was not present in the skeletal muscle cells, but in the immune cells, suggesting that BDNF may participate in the skeletal injury and regeneration through regulating immune cell functions. **Discussion** BDNF has been found capable of regulating satellite cells in skeletal muscle injury and regeneration. Here we observed enhanced BDNF expression and satellite cell activation in the rats in response to downhill running. In addition, our study showed that increased BDNF could activate TrkB in the immune cells. Although skeletal muscle can release BDNF in response to exercise as a secretory organ, it is not the only source of BDNF, immune cells could also express BDNF and TrkB. Our study suggests that in addition to regulating satellite cells, BDNF could play an important role in the process of skeletal muscle repair by modulating immune cell functions.

## EFFECT OF HYPOXIA AND DIETARY NITRATE SUPPLEMENTATION ON ADAPTATIONS TO SPRINT INTERVAL TRAINING

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KU Leuven

**INTRODUCTION:** Endurance training in hypoxia elicits unique molecular adaptations in skeletal muscle tissue (Hoppeler et al., 2008). However, less is known about skeletal muscle adaptations to sprint interval training (SIT), where, unlike endurance training, there is little effect of hypoxia on power output (Calbet et al., 2003). Furthermore, although dietary nitrate supplementation is known to increase exercise tolerance in hypoxia (Vanhatalo et al., 2011), it is not known if dietary nitrate supplementation affects adaptations to SIT performed in hypoxic conditions. The aim of this study was to investigate the effect of hypoxia, alone or in conjunction with nitrate, on muscular adaptations and exercise performance responses to SIT. **METHODS:** Twenty-seven moderately-trained participants were randomly allocated to 3 SIT groups: (1) normoxia + placebo (N), (2) hypoxia + placebo (H) or (3) hypoxia + oral nitrate (H-Ni). All participants performed 5 weeks of SIT on a cycle ergometer (4-6 reps, 30-s sprints, recovery intervals of 4 min and 30 s). The normobaric hypoxic facility was set at 20.9% FiO<sub>2</sub> (sea-level) for N, versus 15.0% FiO<sub>2</sub> (~2750 m) for H and H-Ni. Nitrate (6.5 mmol dose) was administered in the form of NaNO<sub>3</sub> capsules 3 h before each training session. Before and after the training period, a biopsy was taken from m. vastus lateralis and the participants completed a maximal incremental exercise test, a 30-min simulated time trial (TT30) and a 30-s all-out Wingate test (W30). **RESULTS:** Power output during the training sessions was similar between the groups. However, compared to N blood lactate concentration in the first sprint, but not in the final sprint of the sessions, was higher ( $P < 0.05$ ) in H and H-Ni. SIT increased neither muscular buffer capacity (Bm) nor the protein content of carbonic anhydrase 3 (CA3) or monocarboxylate transporters 1 and 4 (MCT1 and 4). However, the training intervention increased W30 performance more in H-Ni (+12%,  $P < 0.05$ ) than in N or H (both +6%). SIT increased ( $P < 0.05$ ) muscular citrate synthase activity (+34%), VO<sub>2</sub>max (+12%), power output at OBLA (+8%), and mean power output during TT30 (+6%), but there were no significant differences between groups. **DISCUSSION:** Regardless of whether SIT training was performed in normoxia or hypoxia, alone or in conjunction with oral nitrate intake, SIT increased neither Bm, nor muscle MCTs and CA3 protein expressions. Nonetheless, SIT in H-Ni increased performance in W30 more than SIT in N or H. The mechanism underlying this improvement in anaerobic capacity remains, however, to be elucidated. **REFERENCES:** Hoppeler H. et al., Scand J Med Sci Sports (2008) Calbet J. et al., J Appl Physiol (2003) Vanhatalo A. et al., J Physiol (2011) **CONTACT:** Stefan.desmet@kuleuven.be

**CYCLING POWER MEASUREMENT: LAB TESTS VS INDOOR TRACK TESTS**

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**Introduction** There are indications that an assessment performed in the field produces different results than one performed in the laboratory, and that it might be closer to the real conditions that the athlete encounters (Blake and Wakeling, 2012). In recent years, there has been an increased availability of bicycle power meters, in the consumer market, such as the well-known SRM training system, which has been shown to measure power output accurately (Jones and Passfield, 1998; Wooles et al. 2005). The aim of this paper is to report on a study comparing power measurements performed in the laboratory, using an SRM system mounted on a cycle ergometer, and in an indoor track using the same SRM system mounted in a bicycle. **Methods** Maximal protocol tests were performed by steady intensity levels, during periods of 4 min, starting at 100 W with increments of 50 W. The power output was measured in two different situations with the same SRM Professional system, mounted on a cycle ergometer (Monark 828E) in the laboratory, and mounted on a training bicycle (Look 585) in an indoor cycling track. Target cadence was 90 rpm. The capillary blood lactate concentration was measured, at the end of each of the 4 min intensity level tests, with a Vario Photometer II DP 310. Results For the laboratory tests, power levels of (mean±SD) 98.4±4.7, 149.0±5.1, 198.8±6.4, 248.8±7.6, 299.1±8.4, 351.1±10.6 and 390.9±15.1 W produced, respectively lactate concentration values of 1.1, 0.9, 1.2, 1.2, 2.6, 6.8, 14.3 mmol/l. For the indoor track tests, power levels of 97.9±15.0, 148.5±22.9, 203.1±25.3, 255.1±29.1, 292.0±23.3, 341.8±26.5, 384.0±24.2 W produced, respectively lactate concentration values of 1.2, 1.2, 1.2, 1.4, 2.2, 4.3, 9.3 mmol/l. **Discussion** Observations indicate no difference in the power output at the anaerobic threshold. However, for intensities above the anaerobic threshold, the lactate concentration increased much faster in the laboratory tests compared to the field tests, despite the intensity levels being comparable. One possible explanation for this observation might be the lower thermal stress the athlete is exposed to in the track, since the flow of air helps the body thermoregulation mechanism through forced convection. In the authors' experience, however, this does not seem to completely explain such large differences. The observed variability of the measured power might also have some effect on the lactate measurements, possibly due to different muscle recruitment patterns. The extent to which this effect can explain the differences observed will be explored in future work. **References** Blake OM, Wakeling JM. (2012). Muscle coordination during an outdoor cycling time trial. *Med. Sci. Sports Exerc.*, 44(5), 939-948. Jones SM, Passfield L. (1998). Dynamic calibration of bicycle power measuring cranks. In: Haake S.J. (ed). *The Engineering of Sport*, Blackwell Science, Oxford, 265–274. Wooles AL, Robinson AJ, Keen PS. (2005). A static method for obtaining a calibration factor for SRM bicycle power cranks. *Sports Engineering*, 8, 137-144.

**Oral presentations****OP-PM11 Thermoregulation I****REGULAR COLD-WATER IMMERSION AFTER HIGH-INTENSITY INTERVAL TRAINING DOES NOT HINDER THE ADAPTIVE RESPONSE IN HUMAN SKELETAL MUSCLE**

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**Introduction** Debate currently exists surrounding the merit of cold-water immersion (CWI) in athletic training regimes. While better recovery may allow for greater training quality and stimulus (Versey et al. 2013), there is suggestion that CWI may attenuate long-term skeletal muscle adaptations (Yamane et al. 2006). Conversely, CWI may stimulate gene expression of key proteins involved in mitochondrial biogenesis (Ihsan, et al. 2014). The aim of this study was to investigate the underlying molecular mechanisms by which CWI may alter the signalling pathways and training adaptations associated with mitochondrial biogenesis following high-intensity interval training (HIT). **Methods** Sixteen males performed six weeks of HIT (4-6 x 30-s all-out cycling efforts), with each session immediately followed by one of two 15-min recovery conditions: CWI (10°C) or a passive room-temperature control (CON; 23°C). To determine both the acute and training molecular responses following HIT and CWI, muscle biopsies were obtained pre-exercise, post-recovery and 3 h post-recovery during the first training session, and at rest 48 h after the final training session. Results When compared with CON, CWI resulted in larger increases in phosphorylated p53 and PHF20 content 3 h post-recovery. Gene expression of p53-downstream targets Mfn2, AIF, and SCO2, as well as the antioxidant catalase, were all elevated 3 h post-recovery for CWI as compared with CON. Training increased PGC-1 $\alpha$ , p53, and PHF20 protein content, CS activity, mitochondrial respiration, VO<sub>2peak</sub> and cycling performance for both conditions, with no difference between groups. HSP70 protein content increased post-training in the CWI group, and remained unchanged in the CON group. **Discussion** We provide novel data demonstrating that post-exercise CWI augments the post-exercise response of a number of signalling proteins and genes associated with mitochondrial adaptations. We hypothesise that the oxidative stress imposed by a hypothermic shock and subsequent rewarming may serve to augment p53 activation post-exercise, leading to a greater upregulation of some of its downstream targets. However, despite these differences following a single bout of exercise, repeated post-exercise CWI following training did not promote a greater adaptive response to HIT, as measured by markers of mitochondrial biogenesis and other endurance-related adaptations. **References** Ihsan M, Watson G, Choo H, Lewandowski P, Papazzo A, Cameron-Smith D, Abbiss C. (2014). *Med Sci Sports Exerc*, 46(10): 1900-07. Versey N, Halson S, Dawson B. (2013). *Sports Med*, 43(11): 1101-30. Yamane M, Teruya H, Nakano M, Ogai R, Ohnishi N, Kosaka M. (2006). *Eur J Appl Physiol*, 96(5): 572-80.

**A COMPARISON BETWEEN CONDUCTIVE AND INFRARED DEVICES FOR MEASURING MEAN SKIN TEMPERATURE AT REST, DURING EXERCISE IN THE HEAT, AND RECOVERY**

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**INTRODUCTION** Skin temperature assessment has historically been undertaken with conductive devices affixed to the skin. With the development of technology, infrared devices are increasingly utilised in the measurement of skin temperature. Therefore, our purpose was to evaluate the agreement between four skin temperature devices at rest, during exercise in the heat, and recovery. **METHODS** Mean skin temperature was assessed in thirty healthy males during 30 min rest (24.0 ± 1.2°C, 56 ± 8%), 30 min cycle in the heat (38.0 ± 0.5°C, 41 ± 2%), and 45 min recovery (24.0 ± 1.3°C, 56 ± 9%). Mean skin temperature was assessed at four sites using two conductive

devices (thermistors, iButtons) and two infrared devices (infrared thermometer, infrared camera). RESULTS Bland–Altman plots demonstrated mean bias  $\pm$  limits of agreement between the thermistors and iButtons as follows (rest, exercise, recovery):  $-0.01 \pm 0.04$ ,  $0.26 \pm 0.85$ ,  $-0.37 \pm 0.98^\circ\text{C}$ ; thermistors and infrared thermometer:  $0.34 \pm 0.44$ ,  $-0.44 \pm 1.23$ ,  $-1.04 \pm 1.75^\circ\text{C}$ ; thermistors and infrared camera (rest, recovery):  $0.83 \pm 0.77$ ,  $1.88 \pm 1.87^\circ\text{C}$ . Pairwise comparisons of mean skin temperature found significant differences ( $p < 0.05$ ) between thermistors and both infrared devices during resting conditions, and significant differences between the thermistors and all other devices tested during exercise in the heat and recovery. CONCLUSION These results indicate poor agreement between conductive and infrared devices at rest, during exercise in the heat, and subsequent recovery. Infrared devices may not be suitable for monitoring mean skin temperature in the presence of, or following, metabolic and environmental induced heat stress.

### **HYPERTHERMIA ALTERS PROPRIOCEPTION AND BALANCE**

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Background: Poor proprioception has been proposed to result in a lower level of performance and a higher incidence of injury. Proprioception depends on muscle properties, nerve conduction velocity, spinal function and brainstem activity. However, recent studies showed that these factors are all negatively affected by hyperthermia. The aim of this study is to investigate the effect of passive hyperthermia on proprioception and balance. Methods: Following a familiarization trial, 14 volunteers (8 males, 6 females,  $176 \pm 7$  cm,  $73 \pm 8$  kg,  $32 \pm 4$  yrs) underwent 2 experimental sessions in temperate (CON,  $24^\circ\text{C}$ ) and hot (HOT,  $48$ – $50^\circ\text{C}$ ) conditions, in a counterbalanced order. During each session, participants performed a proprioception test (movement discrimination of ankle dorsiflexion), a balance test (SEBT: Star Excursion Balance Test, in medial, antero-medial and postero-medial directions), and a neural assessment (electrically evoked M-wave and H-reflex on the soleus -SOL- and the gastrocnemius -GM- muscles), in randomized order. Rectal and mean skin temperatures (chest, arm, leg, shin) were continuously monitored. Results: Core temperature was clamped at  $39^\circ\text{C}$  during HOT. Both core ( $39.0 \pm 0.3$  vs.  $36.9 \pm 0.6^\circ\text{C}$ ) and skin ( $37.9 \pm 1.0$  vs.  $32.0 \pm 2.7^\circ\text{C}$ ) temperatures were significantly higher in HOT than CON ( $p < 0.05$ ). The mean error during the proprioception test was significantly higher in HOT ( $0.6 \pm 0.1$  deg) than CON ( $0.5 \pm 0.1$  deg,  $p < 0.05$ ). In addition, hyperthermia significantly decreased the average distance reached during the SEBT ( $90.9 \pm 6.1$  vs.  $88.6 \pm 7.9$  cm in CON and HOT respectively,  $p < 0.05$ ) due to a significant decrease of the distance reached in the postero-medial direction ( $98.4 \pm 6.3$  vs.  $94.1 \pm 8.6$  cm in CON and HOT respectively,  $p < 0.05$ ). Maximal amplitude of H-reflex was reached at a similar intensity of stimulation in CON and HOT ( $p < 0.05$ ). However, maximal H-reflex amplitude was significantly lower in HOT than CON (SOL:  $2.5 \pm 1.1$  vs.  $4.3 \pm 1.9$  mV, GM:  $1.6 \pm 0.8$  vs.  $2.4 \pm 1.4$  mV, in HOT and CON respectively,  $p < 0.05$ ), without significant differences in M-wave. The alterations in proprioception, balance and neural functions were not correlated between themselves. Conclusion: The current study demonstrated that hyperthermia alters both proprioception and balance.

### **THE WHOLE BODY CRYOSTIMULATION DOES NOT CHANGE IRISIN CONCENTRATION BUT REDUCES INFLAMMATION IN MIDDLE AGED, OBESE MEN.**

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Introduction Irisin has been proposed to mediate the beneficial effects of exercise on metabolism, inducing browning of adipocytes as well as thermogenesis by increasing uncoupling protein 1. This newly discovered peptide in a study by Böström et al. (2012) might be secreted by muscle and released into the blood flow in response to exercise. Similarly to physical exercise, exposure to extremely low temperature potentiates thermogenesis and muscle contractions, which might also lead to the secretion of irisin. Consequently, the aim of this study was to investigate the effect of the whole body cryostimulation on irisin concentration in middle aged men. Methods A group of middle aged men ( $38 \pm 9$  years old,  $\text{BMI} > 30 \text{ kg}\cdot\text{m}^{-2}$ ) participated in the study. Subjects were exposed to a series of 10 sessions in a cryogenic chamber (once a day at 9:30am, for 3 min, at temperature  $-120^\circ\text{C}$ ). Prior to treatment body composition and fitness level were determined. Blood samples were collected before the first cryostimulation and after completing the last one. Results Most of our participants exhibited low grade systemic inflammation in response to the elevated fat tissue. Thus, the enhanced values of C-reactive protein ( $3.2 \pm 1.8 \text{ mg}\cdot\text{l}^{-1}$ ) and hepcidin ( $96.8 \pm 32.9 \text{ ng}\cdot\text{ml}^{-1}$ ) were recorded. The whole body cryostimulation significantly reduced the CRP concentration, which dropped 2.3fold compared to the baseline. It also decreased the pro-inflammatory, iron-regulating protein- hepcidin, however, the differences observed did not significantly affect iron or ferritin status. On the other hand, the applied series of 10 whole body cryostimulation sessions did not modify blood irisin concentration. Discussion The investigation revealed that a series of 10 whole body cryostimulation sessions resulted in a significant decrease of the pro-inflammatory proteins in middle aged men. Therefore, the whole body cryostimulation might act as an anti-inflammatory strategy, which is in agreement with our previously published study (Ziemann et al., 2013). Oppositely to our expectations, the whole body cryostimulation did not change irisin concentration in the group of obese subjects, which rules this treatment out as a factor enhancing energy expenditure. References 1. Bostrom et al (2012) A PGC1- $\alpha$ -dependent myokine that drives brown-fat-like development of white fat and thermogenesis. *Nature* 2012 Jan 11;481(7382):463-8 2. Ziemann E et al (2013) Whole-body cryostimulation as an effective method of reducing low-grade inflammation in obese men, *J Physiol Sci.* 2013; 63: 333–343.

### **EFFECT OF ISCHEMIC PRECONDITIONING ON SWIMMING PERFORMANCE IN A HIGH-INTENSITY INTERVAL TRAINING SET: A RANDOMIZED, PLACEBO AND NOCEBO-CONTROLLED STUDY**

Ferreira, T.N.1,2, Lopes, T.R.1,2,3, Sabino-Carvalho, J.1,2, Freitas, T.O.1,2, Silva, A.C.1,2, Silva, B.M.1,2

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Introduction Recent studies have shown that ischemic preconditioning (IPC) improved competitive swimming performance (1.1% in 100-m and 200-m time trials; Jean-St-Michel et al. 2011). But, it is conceivable that IPC can also improve performance in training sessions, which could be valuable to enhance training tolerance and adaptations. Moreover, no study has adequately controlled possible placebo/nocebo effects of IPC. Thus, our aim was to study the effect of IPC on swimming performance in a high-intensity interval training (HIT) set. Methods Well-trained swimmers were recruited. Group 1 ( $n = 13$ ,  $24 \pm 3$  years) was randomly submitted to IPC and control (CT). IPC: cuffs positioned on the thighs were inflated to 220 mmHg for 5 min and deflated to 0 mmHg for 5 min. CT: the cuffs were inflated to 10 mmHg for 5 min and deflated to 0 mmHg for 5 min. Group 2 ( $n = 6$ ,  $24 \pm 2$  years) was randomly submitted to placebo (PL) and CT. PL: the cuffs were inflated to 10 mmHg for 2 min, 220 mmHg for 1 min and 10 mmHg for 2 min, and then deflated for 5 min. Each cycle of inflation/deflation was repeated three times per day on each leg, at 48h, 24h and 45 min before a HIT set (six 50-m all out efforts, repeated every 3 min). Subjects were informed that both IPC and PL would improve performance compared to CT. The improvement expectation

with IPC and PL was 92% (12 out of 13 subjects) and 83% (5 out of 6 subjects), respectively. Measurements included: swimming time [best time (BT), total time (TT), and percent decay (%DC)], swimming kinematics [mean velocity (MV), stroke rate (SR) and stroke length (SL)], blood lactate concentration [La] and rating of perceived exertion (RPE). Results IPC did not change BT ( $P = 0.37$ ), %DC ( $P = 0.41$ ), [La] ( $P = 0.30$ ), RPE ( $P = 0.24$ ) and swimming kinematics ( $P = 0.70, 0.25$  and  $0.44$ ). Conversely, it tended to decrease TT ( $-0.8\%$ ;  $P = 0.11$ ). No difference occurred between CT and PL. Discussion These preliminary results show that the trend for improvement in performance with IPC was not accompanied by change in [La]. Thus, it may be explained by enhancement in oxidative metabolism and/or overall efficiency for ATP resynthesis (Cabrera et al. 2012). Noteworthy, no previous study has avoided the placebo/nocebo effect of IPC on exercise performance. The lack of difference between PL and CT procedures in our study indicates, for the first time, that IPC can per se improve performance. References Cabrera JA et al. (2012). *Am J Physiol Heart Circ Physiol*, 302, 1974-82. Jean-St-Michel E et al. (2011). *Med Sci Sports Exerc*, 43, 1280-6.

### EFFECTS OF EXTERNAL MOTIVATION ON CYCLING TIME TRIALS

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Introduction: Motivation is a key element of an athlete's success. Intrinsic motivation seems to have a positive influence on concentration and effort whilst high external motivation may decrease intrinsic motivation and possibly compromise performance (Deci et al., 1999). This has further been associated with the adoption of an aggressive pacing pattern (Hulleman et al., 2007). Therefore, the aim of this study was to determine the influence of altering external motivation through a financial reward on pacing and performance in short and long cycling time trials. Methods: 23 cyclists (6 ♀, 17 ♂) completed 4 time trials (TT) on an electromagnetically braked cycle ergometer. Participants were separated in 2 groups based at 2 separate universities. Prior to the first TT, cyclists within one group ( $n=11$ ; PRI) were informed that prize money is available based on the highest mean power output (Pmean) in all TTs. Cyclists within the other group ( $n=12$ ; CON) were not provided with a financial reward. Groups were matched based on their maximum power output determined from an incremental cycling test (PRI:  $392.0 \pm 46.2$ , CON:  $397.8 \pm 41.2$ ;  $p=0.75$ ). In a randomised order and separated by 3 to 7 days all participants performed 4 self-paced TTs. TTs consisted of two long (20 km & 30 min) and two short (4 km & 6 min) trials. Heart rate (HR) and rating of perceived exertion (RPE) were collected every 10% and power output averaged every 10% of each trial. Distance/duration covered was the only feedback provided. Results: No significant differences between motivation types were observed in Pmean, total time and/or total distance duration in either the short ( $p>0.72$ ) or long TTs ( $p>0.81$ ). No significant difference was found in HRmean and RPEmean ( $p>0.07$ ). Compared with CON, power output of PRI was significantly lower upon commencement of both short TTs ( $p<0.02$ ) and the 20 km TT ( $p=0.01$ ; first 10% of each trial). No significant difference in pacing was found between groups in the 30 min TT ( $p=0.95$ ). Discussion: External motivation in the form of a financial reward does not affect overall performance of trained cyclists performing in short and long time trials. Nonetheless, it seems that cyclists pace themselves in a more conservative manner when competing for a reward, which is in contrast to existing theories assuming a more aggressive pace when external motivation is high (Hulleman et al., 2007). The change in pace might be related to decreased internal motivation resulting in lower effort at the start of the trials. References: Deci EL, Ryan RM, Koestner R (1999). *Psychological Bulletin*, 125(6), 627-668. Hulleman M, DeKoning JJ, Hellinga FJ, Foster C (2007). *Med Sci Sport Exerc*, 39(7), 709-715.

## Oral presentations

### OP-PM26 Physiology: Brain

#### THE INFLUENCE OF A MILD THERMAL CHALLENGE AND SEVERE HYPOXIA ON SERUM BDNF.

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Introduction A thermal challenge deteriorates not only exercise performance, but also cognitive performance. One of the key neurotrophins involved in exercise-induced long-term potentiation, growth, and survival of new neurons, is Brain-Derived Neurotrophic Factor (BDNF). BDNF inhibits cell apoptosis and promotes repair processes and is therefore an important mediator for maintaining homeostasis. Levels of BDNF show consistent increases due to exercise in ambient temperatures of  $\pm 18^\circ\text{C}$  in humans and animals [1], mainly through an increased release from the brain [2]. However, very few studies looked at the combined effects of altitude and environmental temperature-induced stress on the serum levels of BDNF. The purpose of the present study was to examine the effects of different environmental stressors on levels of BDNF. Methods Nine trained male athletes (Age:  $23 \pm 3$ y; Wmax:  $333 \pm 45$ W) completed 4 experimental trials (CON:  $15^\circ\text{C}/0\text{m}$ , ALT:  $15^\circ\text{C}/3800\text{m}$ , TEMP:  $25^\circ\text{C}/0\text{m}$ , ALT+TEMP:  $25^\circ\text{C}/3800\text{m}$ ) in a double blind, randomized, cross-over design. Subjects cycled for 30min, starting at  $75\%W_{\text{max}}$ . Blood samples were collected to determine the level of serum BDNF pre and post exercise. Statistical analysis were performed using a two-way (temperature x altitude) repeated measures analysis of variance (ANOVA). Differences were considered significant when  $p<0.05$  was achieved. Results There were no interaction effects between time, altitude and temperature for BDNF ( $P>0.30$ ). We did observe a significant main effect of time ( $P=0.005$ ; Fig. 4b). BDNF concentration was greater post exercise ( $26.5 \pm 10.9\text{ng/mL}$ ) compared to pre exercise ( $21.8 \pm 8.4\text{ng/mL}$ ) in all conditions. Discussion Both acute exercise and a thermal challenge have already been observed to increase BDNF concentrations [1,3]. The current study, however, was the first to examine the effect of acute altitude exposure on BDNF. We observed that 90min in a hypoxic condition did not change BDNF concentration. In line with previous literature, exercise significantly increased BDNF in the present study. Yet, contradictory to the findings of Goekint et al. [3] we did not observe a significantly higher increase in BDNF by adding a thermal stressor. In the present study, a smaller magnitude of thermal stressor was used ( $25^\circ\text{C}$  vs  $30^\circ\text{C}$ ), what might explain the smaller response of BDNF. References 1.Knaepen, K, et al., *Sports Medicine*, 2010, 40(9): 765-801. 2. Rasmussen, P, et al., *Experimental Physiology*, 2009, 94(10): 1062-1069. 3. Goekint, M, et al., *Neuroscience Letters*, 2011, 494(2): 150-154. Contact ctonoli@vub.ac.be

### PHYSICAL EXERCISE ACTIVATES THE MU-OPIOID SYSTEM IN HUMAN BRAIN

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**Objectives:** Physical endurance exercise reduces stress and anxiety, elevates mood, and relieves pain, but the underlying neurobiological mechanisms responsible for these beneficial psychophysical effects remain largely unknown. The central opioidergic mechanisms likely modulate these effects and play an important role in exercise-induced euphoria ("runner's high") [1]. In this study, we sought to the opioid hypothesis of exercise-induced euphoria by measuring mu-opioid receptor availability in vivo in healthy males twice, before and after aerobic exercise. **Methods:** Eleven recreationally active healthy men (age:  $25 \pm 4$  years, BMI:  $22.8 \pm 1.2$ ,  $VO_{2max}$ :  $50.1 \pm 6.3$  mL/kg/min) were studied with positron emission tomography (PET) and a bolus injection of [ $^{11}C$ ]carfentanil. Participants underwent two consecutive [ $^{11}C$ ]carfentanil PET scans in random order: after rest and after 60 min of aerobic endurance cycling, on separate days. Cycling was performed at a workload between aerobic and anaerobic thresholds ( $154 \pm 41W$ ) predetermined individually in maximal oxygen uptake test. Voxel-wise mu-opioid receptor availability was quantified with simplified reference tissue model using occipital cortex as the reference region, and statistical parametric mapping was used to compare availability maps between the two conditions. **Results:** Acute exercise increased the availability of mu-opioid receptors in anterior cingulate cortex, prefrontal and temporal cortex (cluster-level FDR-corrected  $p$ -value  $< 0.05$ ). ROI analysis indicated that exercise increased mu-opioid receptor availability 7-10% in these regions. **Conclusion:** This study provides preliminary evidence that acute exercise modulates the brain mu-opioid system in recreationally active men. Activation of the brain mu-opioids may be responsible for various beneficial psychophysical effects of physical exercise. Individual differences in these mechanisms may reveal why some people enjoy physical exercise more than others, and may therefore have important public health implications. **Research support:** Academy of Finland, Sigrid Juselius Foundation, Turku Collegium of Science and Medicine, Turku University Hospital (EVO) **References:** [1] Boecker, H et al. *Cereb Cortex* 2008, 18:2523-253

### VISUAL ACUITY AND CONTRAST SENSITIVITY ARE NOT AFFECTED BY HYPOXIC CONDITIONS IN SHORT-TERM AND LONG-TERM ACCLIMATIZED HIKERS

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Department of Sports Medicine and Sports Nutrition, Faculty of Sports Science, Ruhr-Universität Bochum, Germany **Introduction** Morphological and functional changes of the visual system, e.g. a reduction of color discrimination or altered retinal blood flow, have been shown during hypoxic conditions (Grimm et al., 2012). Central (static) visual performance is an essential basic requirement for optimal visual perception and acting in sport (Schnell, 1999). Movement control and balance regulation require central and peripheral visual information. In the context of modern mountaineering these skills are obligatory. But it is unclear so far in which way hypoxic exposure has an effect on visual acuity (VA) and contrast sensitivity (CS). The aim of the study was to analyze VA and CS during hypobaric hypoxic conditions in short-term and long-term acclimatized healthy young hikers. **Methods** 10 eye-healthy moderately trained students (male:  $n=8$ , female:  $n=2$ ;  $23.0 \pm 2.9$  years; refraction error s.c.  $< 1.6$  dpt) were investigated during and 3 months after (d+90: 156 m) a 9-day Mt. Kilimanjaro ascent (d1-d9; sleeping level: 890-3995 m, total height 5895 m). We measured VA and CS with the help of a computer-based Landolt- and Sine Wave Contrast-test as developed by Bach (1996) on a high definition notebook in a light-impermeable tent. VA and CS were analyzed on days 1 and 9 (d1/d9: 890 m), day 3 (d3: 3829 m) and day 6 (d6: 4530 m). In addition, morning oxygen saturation ( $mSaO_2$ ) and Lake Louise score (LL) were determined. **Results** VA and CS remained constant during altitude on d3 and d6 compared to d1/d9/d+90 ( $p > 0.05$ ) (mean  $\pm$  SD: d1, d3, d6, d9, d+90); VA:  $1.85 \pm 0.57 / -0.43$ ,  $1.75 \pm 0.60 / -0.45$ ,  $1.88 \pm 1.05 / -0.67$ ,  $1.84 \pm 0.70 / -0.51$ ,  $1.96 \pm 0.85 / -0.59$ ; CS (grating threshold; 15 cpd):  $0.37 \pm 0.11$  %,  $0.47 \pm 0.24$  %,  $0.49 \pm 0.30$  %,  $0.33 \pm 0.02$  %,  $0.45 \pm 0.41$  %, respectively). On d3 and d6 10 % of the subjects were diagnosed with mild acute mountain sickness (LL=4; 90 %  $< 3$ ; =3), and all had  $mSaO_2$  values  $> 89$  % (range=89.4-96.9 %). **Discussion** Our data suggest that hiking in hypobaric hypoxia does not affect VA and CS in short-term and long-term acclimatized healthy young students. However, in the context of prior studies it can be suggested that good acclimatization also benefits visual perception performance at high altitude and reduces the risk of accidents because of vision loss (Willmann et al., 2010). This is in line with studies demonstrating the sensitivity to acute hypoxic stimuli of mainly peripheral and not central vision (e.g. Horng et al., 2008). **References** Bach M (1996). *Optom Vis Sci*, 73(1), 49. Grimm C et al. (2012). *High Alt Med Biol*, 13(3), 169. Horng CT et al. (2008). *ASEM*, 79(7), 666. Schnell D (1999). *Dtsch Arztebl*, 96(14), 925. Willmann G et al. (2010). *Br J Ophthalmol*, 94, 1393.

### PHYSICAL AND MENTAL EXERTION REDUCE COGNITIVE PERFORMANCE ON PROFESSIONAL FOOTBALL PLAYERS

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**Introduction** Modern football requires periods of high intensity intermittent physical efforts (Stølen T. et al., 2005) and sustained attention to perform optimally. This physical and mental exertion may negatively affect cognitive performance. Recent studies have shown an association between mental fatigue and reductions of both cognitive (Boksem MA, Tops M. 2008) and endurance performance (Mancora S. et al., 2009). Accordingly, the purpose of this field study was to measure the effect of mental and physical exertion on cognitive performance on professional football players. **Methods** In a double-blind, randomized crossover experimental study, 17 male professional football players were recruited. Players underwent a repeated sprint exercise (RSE) consisting in 10 maximal shuttle sprints of 20+20 m interspaced by 20 s of recovery. RSE test was performed after 30 min of demanding cognitive task (Stroop test) in the experimental condition (EXP) or 30 min of non-demanding cognitive task (watching a documentary) in the control condition (CON). Running speed, heart rate (HR) and rating of perceived exertion (RPE) were monitored after each sprint. A 3 min Psychomotor Vigilance Test was performed at rest, after the cognitive tasks, and after RSE test to quantify their effect on cognitive performance (CP). Brain oxygenation level was monitored by near infrared spectroscopy (NIRS) on left prefrontal cortex during RSE. **Results** HR and RPE significantly increased, while running speed decreased over sprints ( $p < 0.05$ ) but there were no significant differences between conditions ( $p > 0.05$ ). CP was significantly reduced in EXP condition after the Stroop task ( $p < 0.05$ ). RSE reduced CP in both conditions ( $p < 0.05$ ) with follow-up tests revealing a significantly lower CP in the EXP condition ( $p < 0.05$ ). No significant differences were found regarding NIRS between conditions ( $p > 0.05$ ). **Discussion** The results of this study suggest that both RSE and prolonged mental exertion negatively affect CP in professional football players. However, mental fatigue does not affect RSE performance. In conclusion, we suggest that in addition to physical training, other strategies should be employed to reduce the cognitive impairment associated with intensive physical and mental exertion commonly encountered within

football matches. References 1 Stølen T. et al (2005) Sports Med. 2005 35:501-36; 2 Boksem MA, Tops M. (2008) Brain Res Rev. 2008 59:125-39; 3 Marcora S. et al (2009) J Appl Physiol. 2009 106:857-64;

### DOES EXERCISE PREFERENCE OR ADAPTATION MATTER FOR THE EFFECT ON BRAIN CORTICAL ACTIVITY?

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A previous study showed differences between post-exercise brain cortical activities dependent on exercise mode (Brümmer et al. 2011). Because a decrease of brain cortical activity was revealed following running exercise but not bicycling, arm-cranking or isometric strength exercise, it was hypothesized that exercise preference or adaptation might play a role for the post-exercise effect on brain cortical activity. The present study aimed to proof the preference/adaptation hypothesis by testing a group of triathletes, who are adapted to both running and bicycling, but who prefer one of the two exercises. Ten professional triathletes were asked to perform two modes of triathlon (bicycling and running), each at their individual self-chosen intensity under field conditions. Electroencephalography (EEG) was recorded for 3min by 32 surface electrodes under rest conditions before (PRE), directly after (POST=0), 15min (POST15) and 30min (POST30) after exercise. Low-resolution brain electromagnetic tomography (LORETA) was applied to localize and export mean current density values ( $\mu\text{V}2/\text{mm}4$ ) of the frontal, parietal, occipital and temporal lobe. The effect of exercise mode (bicycling, running), time (PRE, POST0, POST15, POST30) and preference (preferred, non-preferred) was calculated by ANOVA. Brain cortical activity decreased following running exercise comparing PRE and POST0, POST15 and POST30 within the frontal ( $p < .001$ ), parietal ( $p < .001$ ), occipital ( $p < .001$ ) and temporal lobe ( $p < .001$ ). No differences were found for bicycling exercise. No effect of exercise mode but an interaction of time and mode has been found for all regions of interest (frontal  $p = .012$ , occipital  $p = .048$ , parietal  $p < .001$ , temporal  $p = .005$ ). PRE measurements of running and bicycling exercise did not differ ( $p > .27$ ). Comparing the trials of the preferred with non-preferred mode revealed no difference for all regions of interest (frontal  $p = .943$ , occipital  $p = .438$ , parietal  $p = .987$ , temporal  $p = .664$ ). The previously shown effect of exercise mode could be confirmed. This study shows that brain cortical activation state after exercise is not adaptation dependent. The hypothesized effect of exercise preference was disproven on the basis of the present group of triathlon athletes. Further studies using athletes with one concrete exercise preference should be used for verification. It is suggested that brain cortical activity after running exercise decreases due to the characteristics of running exercise.

## Oral presentations

### OP-BN12 Musculoskeletal & Fatigue

#### PREDICTIVE MUSCULOSKELETAL SIMULATION OF UPHILL AND DOWNHILL RUNNING

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**Introduction** Predicting human responses to environmental changes is necessary for biomechanical analysis and sports product design. If case studies, environmental conditions or prototypes cannot be realized, modeling and simulation can be used instead. The aim of this work was to evaluate a method of predictive musculoskeletal simulation (van den Bogert et al., 2012) for uphill and downhill running. The predicted energy costs for running at different slopes were compared to literature (Minetti et al., 2002). **Methods** The 2D model consisted of seven body segments: trunk, thigh, shank and foot in each leg. In the model, 16 Hill-type muscles and passive joint structures generated joints moments. Slopes in the range of  $-30^\circ$  to  $30^\circ$  were modeled. A case study was simulated with 20 "subjects" by randomly changing the muscle parameters. The predictive simulation was formulated as an optimal control problem: The objective function consisted of a tracking and an effort term. The constraints were given by the implicit formulation of musculoskeletal dynamics and the periodic forward movement. The resulting optimal control problem was solved for each "subject" independently by using IPOPT (<http://www.coin-or.org>). **Results** The metabolic power was estimated from the average power done by the modeled muscle fibers based on Margaria, 1968. As a result, the metabolic energy costs (MEC) were obtained by dividing the metabolic power by the "subject's" mass and the forward speed. Its mean and standard deviation over all "subjects" in [J/kg/m] for the slopes  $-30^\circ:5^\circ:30^\circ$  were  $6.59 \pm 1.88$ ,  $5.66 \pm 2.34$ ,  $4.81 \pm 1.06$ ,  $4.68 \pm 0.88$ ,  $4.56 \pm 0.70$ ,  $4.88 \pm 0.60$ ,  $5.85 \pm 0.54$ ,  $8.30 \pm 0.86$ ,  $12.01 \pm 1.12$ ,  $15.73 \pm 2.05$ ,  $19.32 \pm 2.20$ ,  $23.04 \pm 2.95$ ,  $26.88 \pm 4.10$ . For uphill running, the mean MEC was increasing directly proportional to the slope. The optimal downhill slope and the increase of the MEC for uphill running were in agreement with literature (Minetti et al., 2002). **Discussion** For further evaluation, the estimation of the MEC from the mechanical power should be avoided. Future work should consider muscle models that include equations to directly calculate the MEC (e.g. Umberger et al., 2003). **References** Margaria, R. (1968). *Int Z Angew Physiol*, 25(4), 339-351. Minetti, A. E., Moia, C., Roi, G. S., Susta, D., Ferretti, G. (2002). *J Appl Physiol* 93(3), 1039-1046. Umberger, B. R., Gerritsen, K. G., Martin, P. E. (2003). *Comput Meth Biomech Biomed Eng* 6(2), 99-111. van den Bogert, A. J., Hupperets, M., Schlarb, H., Krabbe, B. (2012). *Proc Inst Mech Eng, Part P: J Sports Eng Technol* 226: 123-133. Contact [eva.dorschky@fau.de](mailto:eva.dorschky@fau.de)

#### SEASONAL VARIATIONS IN SKIING ECONOMY IN ELITE CROSS-COUNTRY SKIERS ARE ASSOCIATED WITH CHANGES IN SKIING TECHNIQUE

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**Introduction** Oxygen cost (O<sub>2</sub>-cost) is associated with athletes' performance level in cross-sectional studies of cross-country (XC) skiers (e.g. Sandbakk et al., 2010). Further, reduced O<sub>2</sub>-cost during the season was associated with improvement of performance during treadmill ski skating (Losnegard et al., 2013). The aim of this study was to determine how seasonal variations in technical factors was related to changes in O<sub>2</sub>-cost and 1000 meter time-trail performance (1000-m time) in elite XC-skiers. **Methods** Eleven male elite XC-skiers (all top 30 in the Norwegian Championship) performed submaximal and maximal tests on a roller ski treadmill in June, August, October, and January. Pole and hip acceleration was assessed by 3D-accelerometers for determination of cycle characteristics and total hip accelerations (root-mean square (RMS) of resultant acceleration) during treadmill V2 ski-skating at a high load ( $6^\circ$ , 3.5 m/s, oxygen

demand 74-76 ml/(kg•min)). Log-transformed changes from individual mean values were used for Pearson's correlations between technique parameters and sub-maximal O<sub>2</sub>-cost and 1000-m time. Results Changes in O<sub>2</sub>-cost was highly associated with changes in CT ( $r = -0.71$ ) and CT changes were highly associated with changes in RMS hip acceleration during the gliding phase (phase between leg kick and pole thrust) ( $r = -0.80$ ). Further, changes in hip acceleration during the gliding phase were highly associated with changes in 1000-m time ( $r = 0.64$ ) and oxygen cost ( $r = 0.63$ ). Discussion As shown previously (Losnegard et al., 2013), improvement in performance (1000-m time) is associated with change in exercise economy (O<sub>2</sub>-cost). Here we show that changed O<sub>2</sub>-cost is highly associated with hip acceleration, especially during the gliding phase. The findings indicate that better balance during the unsupported ski gliding phase is important for improving O<sub>2</sub>-cost and performance in elite cross-country skiers. References Losnegard T et al. (2013). Seasonal variations in VO<sub>2</sub>-max, O<sub>2</sub>-cost, O<sub>2</sub>-deficit, and performance in elite cross-country skiers. *J Strength Cond Res*, 27(7), 1780-1790. Sandbakk Ø et al. (2010). Metabolic rate and gross efficiency at high work rates in world class and national level sprint skiers. *Eur J Appl Physiol*, 109(3), 473-481. Contact Håvard Myklebust, email: havard.myklebust@nih.no

## CHARACTERISTICS OF MUSCLE AND TENDON MECHANICAL PROPERTIES FOR SPURTERS AND SWIMMERS

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Introduction The regulation of joint stiffness can play important roles for sport activities. On land, for example, the sprint runners can utilize high impact force to utilize elastic energy during contact of running. Specific muscle-tendon interaction have been examined during human running and jumping (e.g. Ishikawa & Komi 2008). In swimming, however, the stress of Achilles tendon (AT) is low and the joint flexibility is very high for swimmers. With these different impact stress conditions, their muscle-tendon properties of triceps surae muscles may be adapted to their specific sport environments. Therefore, the purpose of this study was to examine the muscle architectures and mechanical properties of triceps surae for sprinters and swimmers. Methods Forty-eight young male subjects (21.1±2.8 yr, 1.72±0.05 m, 65.8±5.5 kg) including the twenty-one sprint runners (SPRT), the seventeen swimmers (SWIM), and the ten healthy control subjects without any competitive sport experiences (CTRL) were participated in this study. To stretch plantar flexor muscles passively, their ankle joint were dorsiflexed from 20 degree plantar flexion (-20°) to 10 degree dorsiflexion (+10°) at the seated position with the knee straight on a dynamometer. To measure the AT stiffness, the isometric maximal voluntary plantar flexion contraction (MVC) at 0 degree of ankle joint (0°) was performed. Changes of passive and active plantar flexor joint torque (PFTQ) as well as the fascicle length (L<sub>Fa</sub>), pennation angle and tendinous tissue length (L<sub>TT</sub>) of medial gastrocnemius muscle (MG) and AT length (LAT) by ultrasonography were measured during passive stretching and MVC. Results/ Discussion The passive PFTQ did not show any significant differences between groups. However, the elongations of the muscle and tendon parts in the passive PFTQ measurements were different between groups. In the passive PFTQ measurements, the stiffness of AT did not show any significant differences. However, the stiffness of the MG fascicles and tendinous tissues were significantly greater in SPRT than in SWIM. The MG L<sub>Fa</sub> and L<sub>TT</sub> stretching were significantly greater in SWIM than in SPRT. In the active MVC measurement, the AT stiffness and Young's modulus were significantly greater in SPRT than in SWIM and CTRL. From morphological parameter, the MG L<sub>Fa</sub> was significantly longer in SWIM than in SPRT and CTRL. These results suggested that stiff AT and muscle in SPRT may play important roles for high ankle joint stiffness during sprint running and that longer MG L<sub>Fa</sub> and compliant muscle in SWIM may play important roles for kicking movements during swimming. Reference Ishikawa M & Komi PV (2008) *Exerc Sport Sci Rev*. 36:193-199.

## EMG ACTIVITY OF THE LOWER LIMB MUSCLES DURING SPRINT CYCLING AT MAXIMAL CADENCE

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Introduction Performances produced during exercises of maximal intensity strongly influence our ability to maximally activate those muscles contributing to the movement. When the movement frequency of maximal exercises is increased, the time window available for activating and deactivating the muscles becomes narrower. According to results of a simulation study, activation-deactivation dynamics could limit sprint cycling performance when cadences increase above optimal cadence (1). The aim of this study was to investigate activation and deactivation of the lower limb muscles during sprint cycling at maximal cadence. Methods Twelve physically active males performed a torque-velocity test and a maximal sprint against no external resistance on a stationary cycle ergometer. Surface EMG (Noraxon, US) was measured from six muscles [gluteus maximus (GMAX), rectus femoris, vastus lateralis (VAS), semitendinosus and biceps femoris, medial gastrocnemius, tibialis anterior]. Normalized peakEMG, minEMG and activation duration (in % of pedalling cycle duration) were calculated for all muscles at two cadences: optimal cadence (C<sub>opt</sub>) and maximal cadence (C<sub>max</sub>). Finally a co-activation index (2) was also computed for two pairs of contralateral muscles (GMAX and VAS) at C<sub>opt</sub> and C<sub>max</sub>. One-way ANOVAs with repeated measures were performed to analyse the effect of cadence on the various EMG variables. Results A reduction in peakEMG (88 ± 16% vs. 74 ± 21%, P<0.05), an increase in minEMG (3 ± 2% vs. 5 ± 4%, P<0.05) and an increase in activation duration (64 ± 13% vs. 75 ± 11%, P<0.05) of the lower limb muscles was observed from C<sub>opt</sub> to C<sub>max</sub>. Co-activation indexes increased for both GMAX (5 ± 3% vs. 17 ± 9%, P<0.05) and VAS (3 ± 2% vs. 7 ± 3%, P<0.05) muscle pairs from C<sub>opt</sub> to C<sub>max</sub>. Participants' C<sub>max</sub> was 218 ± 17 rpm and C<sub>opt</sub> 124 ± 8 rpm. Discussion The EMG results indicate a reduction in the maximal level of activation of the muscles combined with a reduction in their level of relaxation at maximal cadence. In addition, the relative duration of activation of the muscles was increased, leading to a rise in the co-activation of contralateral power producer muscles that probably caused an augmentation of the negative work produced during the pedaling cycle (3). Finally, larger standard deviation values were seen at C<sub>max</sub> compared to C<sub>opt</sub>, indicating greater inter-individual differences in the ability of subjects to perform at high movement frequencies. Reference 1. Van Soest AJK, Casius LJR. (2000). *Med Sci Sport Exer.*, 32(11), 1927-1934 2. O'Bryan SJ, Brown NA, Billaut F, Rouffet DM. (2014). *Neurosci Lett.*, 576, 11-16 3. Neptune, RR, Herzog, W. (1999). *Journal Biomech.*, 32, 1021-1026 Contact david.rouffet@vu.edu.au

## POST-ACTIVATION POTENTIATION DURING AN ISOMETRIC TRAINING SESSION: CONTRIBUTION OF PERIPHERAL AND CENTRAL MECHANISMS

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Introduction Various hypotheses have been investigated in the past to explain the increment of twitch torque after a conditioning contraction, the so called post-activation potentiation (PAP). Recent research highlights the need for recurring activations to optimize the PAP

effect (Froyd, Beltrami, Jensen, & Noakes, 2013). However, there is a lack of literature in the topic of examining peripheral (muscular) and central (neural) factors using a series of isometric maximum voluntary contractions (iMVC), as assessed during an isometric training protocol. Methods Fourteen professional handball male players were tested on twitch torque, H reflex and Mmax of the med. gastrocnemius and soleus muscles. An isometric maximum protocol was applied, which was consisted of 4x6 iMVC plantar flexions of 6s duration, with 15s and 2min interval between the repetitions and sets, respectively. Baseline measurements were assessed after warm-up for 5 minutes before the beginning of the isometric session. Twitch torque and Mmax were captured every 30s while H reflex, every 10 sec during a 5% iMVC contraction. Data were captured with stimulation pattern during the baseline measurements, and 2s after the end of each MVC and during the whole rest interval between each repetition and set, starting with a supramaximal stimulation evoking the twitch torque and Mmax. The best repetition in peak twitch torque within each set was determined and analyzed using ANOVA, with  $\alpha$  set at 0.05. Results Twitch torque for all sets, was significantly greater ( $p < 0.05$ ) compared to the baseline values, with a significant decline ( $p < 0.05$ ) during the 3rd and 4th set compared to the 1st set. Mmax decreased significantly in a similar pattern in both plantar flexor muscles ( $p < 0.05$ ), while there was an increase ( $p < 0.05$ ) in gastrocnemius muscle during the 1st set compared to the baseline values. The H/Mmax ratio of both muscles did not change significantly during the whole experiment ( $p > 0.05$ ). Discussion The results of the current study demonstrate quantitatively the co-existence of PAP and peripheral fatigue. The contribution of central mechanisms in terms of reflex excitability assessed with H-reflex technique was not verified which is in agreement with previous findings using a single iMVC (Xenofondos et al., 2014). It is concluded that peripheral fatigue and changes in the excitation-contraction coupling during and after an isometric training session should be taken into account to optimize performance and the outcome of training protocols. References Froyd, C., Beltrami, F. G., Jensen, J., & Noakes, T. D. (2013). Potentiation increases peak twitch torque by enhancing rates of torque development and relaxation. *J Hum Kinet*, 38, 83-94. doi: 10.2478/hukin-2013-0048 Xenofondos, A., Patikas, D., Kocejca, D. M., Behdad, T., Bassa, E., Kellis, E., & Kotzamanidis, C. (2014). Post-activation potentiation: The neural effects of post-activation depression. *Muscle Nerve*. doi: 10.1002/mus.24533 Contact anthix@phed.auth.gr

### ACTIVATION OF 5HT1A RECEPTORS: A PLAUSIBLE CONTRIBUTOR TO CENTRAL FATIGUE?

D'Amico, J.M., Butler, A.A., Butler, J.E., Gandevia, S.C., Taylor, J.L.

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Introduction: Human performance is limited by central fatigue. During maximal isometric efforts, there is intense descending drive to the motoneurons but motoneuronal output decreases over time. In the adult turtle spinal cord, intense descending drive results in serotonin spillover to the axon initial segment of the motoneurons which activates inhibitory 5HT1A receptors and inhibits action potential generation (1). This has been proposed to contribute to central fatigue. We examined whether activation of 5HT1A receptors can depress motoneurone excitability in humans by examining the effects of a 5HT1A receptor partial agonist, buspirone, on F-waves and cervicomedullary motor evoked potentials (CMEPs). Methods: Participants ( $n=10$ , 4F) attended two experimental sessions where either placebo or a 20mg dose of buspirone was administered orally. Investigators and participants were blinded and the order of drug delivery was randomized. The ulnar nerve was stimulated supramaximally to evoke F-waves in abductor digiti minimi (ADM). Electrical cervicomedullary stimulation elicited CMEPs of ~10-20% of the maximal M-wave (Mmax) in biceps brachii and Mmax was elicited by brachial plexus stimulation. Measurement blocks consisted of 60 F-waves, 5 CMEPs and 2 biceps Mmax. These measurements were repeated 3 times at 10-min intervals prior to pill intake, and every 10 min from 25 to 105 min after pill intake. F-wave and CMEP areas were normalized to Mmax and averaged for each measurement block. F-wave persistence was also measured. Post-drug measurements of F-wave and CMEP areas were normalized to baseline values. Two-way repeated measures ANOVAs were performed for statistical analysis. Results: ADM F-waves were different between treatment conditions with F-wave area  $98 \pm 10\%$  of baseline after placebo and  $69 \pm 12\%$  of baseline after buspirone (mean  $\pm 95\%$  CI,  $p < 0.01$ ). ADM F-wave persistence also decreased after buspirone intake (placebo:  $91 \pm 5\%$  vs. buspirone:  $81 \pm 8\%$ ,  $p < 0.05$ ). Biceps CMEPs after buspirone were also smaller when compared to those after placebo (placebo:  $92 \pm 32\%$  vs. buspirone:  $60 \pm 17\%$ ,  $p < 0.05$ ). ADM and biceps maximal M-waves were unchanged. Conclusion: Activation of 5HT1A receptors with buspirone decreases motoneurone excitability as measured by F-waves and CMEPs. Moreover, F-waves are decreased immediately following sustained maximal contractions in the hand and leg (2). Taken together these results show that activation of 5HT1A receptors through serotonin spillover during voluntary contractions is a plausible contributor to central fatigue. References: 1) Cotel F, Exley R, Cragg SJ and Perrier JF, *PNAS* 110: 4774-4779, 2013. 2) Khan SI, Giesebrecht S, Gandevia SC and Taylor JL, *J Physiol* 590: 4957-4969, 2012. Contact: j.damico@neura.edu.au

## Oral presentations

### OP-SH04 Physical Education & Pedagogics (Children in Sport)

#### SPORT INJURIES IN SCHOOL PE AND IN LEISURE TIME. A STUDY AMONG ADOLESCENTS IN SWEDEN, GERMANY, NEW ZEALAND AND IN THE US.

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1. Kristianstad University, Sweden. 2. Hochschule, Schwäbisch Gmünd, Germany. 3. University of Canterbury, New Zealand. 4. Florida Southern College, USA

Introduction Sport is a large contributing factor to injury among young people. At school most injuries occur during PE (Abernethy & MacAuley, 2003). Sports injuries are highly disadvantageous for students (Van Beijsterveldt et al, 2014) and cause disruption to school and sport. Injuries can lead to physical discomfort, physical inactivity and unnecessary absence from school. Methods A questionnaire including items about self-reported sport participation in leisure time and PE, injuries in leisure time and PE was used among 1011 teenagers aged 15-16 years in Sweden, Germany, New Zealand and in the US. The chi squared test was used, carried out by PASW. Results In total 66% of the students ( $n=1011$ ) reported injuries in leisure time sport and 55 % reported in the school PE. No differences were found among boys and girls, nor in leisure time or school PE. Active students reported injuries to a higher extent, both in leisure time and in school PE. 24 % reported severe injuries from leisure time sport that led to continuous trouble. Students who participated in leisure time sports participated in school PE more frequently than non-sporting students (86 % vs 66 %;  $p=0.000$ ). Students who didn't participate in PE (18%;  $n= 1011$ ) were injured as much as those who always participated in PE. Discussion School PE is not risk free and accounts for a significant



part of all injuries in children and adolescents (Abernethy & MacAuley, 2003). However, all sport injuries among children don't occur in the PE setting. In this study it was shown that a higher prevalence of injuries occurred in leisure time sport than in school PE. Students who were active in leisure time were also active in the school PE, and there might be a transfer effect from unhealed injuries caused in leisure time to the activity in PE. New injuries also occurred in the school setting so PE is not free from incidents. An interesting finding was that students who didn't participate frequently in PE reported injuries in PE to the same extent as students who always participated in PE. This might show that students who participate never or seldom in PE are more inactive in leisure time and are unaccustomed to exercise and might be more fragile and vulnerable for injuries in the PE setting. The active students are more prone to renew old injuries or get new ones when they are active often and to a high extent. References Abernethy, A, MacAuley, D. (2003). Impact of school sports injury. *Br J Sports Med*, 37: 354-355. Van Beijsterveldt, A, Blienkendaal, S, Brink, ., Stubbe, J. (2014). Injuries and risk factors in physical education students. *J of Sci & Med in Sports*, 18, 104.

### THE VALIDITY AND FEASIBILITY OF AN ATHLETIC SKILLS TRACK AMONG 6- TO 12-YEAR-OLD CHILDREN

Hoeboer, J.J.A.A.M., De Vries, S.I., Krijger-Hombergen, M., Wormhoudt, R., Savelsbergh, G.J.P.

*The Hague University of Applied Sciences*

**Introduction** In order to investigate the relationship between children's motor skills and people's physical activity level on the long term (Lloyd et al., 2014), valid assessment tools are needed. The purpose of this study was to examine the feasibility and validity of a new tool: an Athletic Skills Track (AST) to assess fundamental movement skills among 6- to 12-year-old children in a physical education (PE) setting. **Methods** During a PE lesson 463 Dutch children (211 girls, 252 boys; 6-12 years old) completed three tests: the Körperkoordination-Test für Kinder (KTK) (Vandorpe et al., 2011) and two Athletic Skill Tracks (AST-1, AST-2). AST-1 includes manipulative and locomotive skills. AST-2 contains locomotive skills. The validity of AST-1 and AST-2 was examined by correlating the time needed to complete the tracks and the KTK Motor Quotient (MQ) in seven age groups. Differences between boys and girls and between age groups were tested using One-way ANOVA. **Results** The average time to complete AST-1 was  $44 \pm 11$  seconds and  $45 \pm 12$  seconds for AST-2. Overall, there was a moderate correlation between AST-1 and the KTK MQ ( $r = -0.474$  ( $p = 0.01$ )) and a strong correlation between AST-2 and the KTK MQ ( $r = -0.502$  ( $p = 0.01$ )). In general, the correlation coefficients were higher when split up for gender; except the correlation between AST-2 and the KTK MQ for girls ( $r = -0.448$ ). The associations between the Athletic Skill Tracks and the KTK MQ were strongest for 12-year old children (AST-1:  $r = -0.767$ ; AST-2:  $r = -0.727$ ) and weakest for 8-year olds (AST-1:  $r = -0.501$ ; AST-2:  $r = -0.469$ ). **Discussion** The results suggest that children's motor skills can be assessed with a quick, convenient, and low-cost motor competence test in a PE setting. The Athletic Skill Tracks are more valid than most existing assessment tools (Cools et al., 2009) and provide an indication of the fundamental movement skills of children aged 6-12 years. References Cools, W., Martelaer, K. D., Samaey, C., & Andries, C. (2009). Movement skill assessment of typically developing preschool children: a review of seven movement skill assessment tools. *J Sports Sci Med*, 8(2), 154-168. Lloyd, M., Saunders, T. J., Bremer, E., & Tremblay, M. S. (2014). Long-term importance of fundamental motor skills: A 20-year follow-up study. *Adapted Physical Activity Quarterly*, 31(1), 67-78. Vandorpe, B., Vandendriessche, J., Lefèvre, J., Pion, J., Vaeyens, R., Matthys, S., Lenoir, M. (2011). The Körperkoordinationstest für Kinder: reference values and suitability for 6-12-year-old children in Flanders. *Scand J Med Sci Sports*, 21(3), 378-388.

### USING DRAWING AS A GATEWAY TO UNDERSTANDING CHILDREN'S BODILY LEARNING

Suominen, L., Moe, V.F., Engelsrud, G.

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**Introduction** We study children's bodily learning as a part of the ASK-intervention study (Active Smarter Kids). Bodily learning is central to the ASK study, and also a timely topic for Physical Education (PE) research and policy. Because of increasing societal pressure related to fitness, health and achievement, it is important to ask what and how children learn about their bodies and movement capacities, and how this knowledge might impact their developing identities **Methods** We presume that bodily learning encompasses more than children are able to express verbally and as well as more than researchers are able to observe. Thus we have chosen to use drawings as a research tool complementary to interview and observation. We ask how drawing may be used to examine children's lived realities and to stimulate interviews. We asked children to draw something they like very much in PE and something else that they like less. We also asked them to write a short explanation of their drawings. Drawings were analyzed and later used in interviews both to stimulate the subject and as a source for themes **Results** Children expressed that they like different activities for varying reasons. Mirroring normative and cultural expressions of physical activity (PA), the words fun and boring were repeatedly associated with activity, task mastery, playing together with others vs getting exhausted and not mastering the task. A few children said that they liked to express themselves, create their own world or help others. Further focus group and individual interviews with children exposed these submerging themes, and taught us more about how children had interpreted the drawing task. In some cases, the children's drawings illustrated meaningful, lived experiences of PA/PE, while with some other children a similarly complex expression was only drawn out in the interview portion of the research **Discussion** Combining drawing with interviews and observation helped us to form a broader perspective on bodily learning, thus proving it an applicable method in studying this phenomenon. It became clear that drawings need to be interpreted in their cultural and situational context. Also, different methods may be necessary to help different children to reflect on meaningful, lived experiences, and the nature of the knowledge produced needs to be discussed References Azzarito, L (2010). Ways of Seeing the Body in Kinesiology: A Case for Visual Methodologies. *Quest*, 62, 155-170 Darbyshire, P, MacDougall, C & Schiller W(2005). Multiple methods in qualitative research with children: more insight or just more?. *Qualitative Research*, 5:4, 417-436 Enright, E & O'Sullivan, M (2012). "Producing different knowledge and producing knowledge differently": rethinking physical education research and practice through participatory visual methods" *Sport, Education & Society*, 17:1, 35-55

### STUDY OF THE PE TEACHERS' CONFLICT MANAGEMENT STRATEGIES

Németh, Zs.

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**Introduction** The physical education teachers are faced with a lot of conflicts during their work. This is natural, because interpersonal relationships already contain the conflicts (Coleman et al., 2014). If these conflicts get on surface, PE teachers try to solve them in a variety of ways. In my opinion, the quality of the management of conflicts is strongly influenced by the teaching-learning process efficiency, so we need a deeper analysis of the most common conflicts. **Methods** I made 16 interviews with physical education teachers of different

ages and different types of schools. Among the participants there were men and women who were at the beginning, the middle and the end of their career of physical education teaching. The questions referred to the different types of physical education classes and the most common places, causes and conflict-resolving methods during different competitions. Results The consequence of their interviews was that conflict management strategies were influenced the best by the situations, the students communication style, the type of physical education and age characteristics of the age groups. Such exercises should be differentially planned for the skill-developing lessons during the implementation of which all participants can achieve experience of success (Shimon, 2011). Physical education teachers need to create an atmosphere that reduces the probability of conflicts to the minimum. The personal exemplary of physical education teachers may improve the situation. Discussion The aim of my lecture is to call attention to the factors which can influence the PE teachers' attitude in teaching-learning process efficiency. By this research I would like to help my PE teacher colleagues to develop effective conflict management. References Shimon, Jane (2011): Introduction to Teaching Physical Education. Principles and Strategies. Human Kinetics. Coleman Peter T. – Deutch Morton – Marcus Eric C. (2014): The Handbook of Conflict Resolution. Theory and Practice. Jossey-Bass. Contact zsoln.nemeth@gamma.ttk.pte.hu

## **TALENT PRODUCTION IN INTERACTION - USING PERFORMANCE APPRAISAL INTERVIEWS IN TALENT SELECTION CAMPS**

Kilger, M.1, Jonsson, R.2

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Introduction In sport, the practice of identifying young talents has become increasingly important as sports for decades are far more than a leisure activity for children; it is a potential professional career (McGarry, 2010). Therefore, Sport Associations need to construct sustainable systems for talent identification in order to legitimize child selection (Helle-Valle, 2008). Critics of the selection attempts are not lacking, however; both the low accuracy of the sample as well as the social costs associated with the activity, has been critically discussed (Anshell & Lidor, 2010; Peterson, 2011). One obvious difficulty is the need to, not only evaluate an individual's current ability, but also her ability to develop and make progress in the future. Therefore, different types of performance appraisal interviews (henceforth, PAI) are becoming increasingly common (MacLean, 2001). The interview has been regarded as a tool for mapping the interviewee's performances and development and what is said is considered to say something important about the child's attitudes or characteristics. Data and Methods Departing from fieldwork in two selection camps for the youth national teams and district teams in ice-hockey and soccer, we will take a closer look at the PAIs, as it is employed during these camps. The empirical material is based on 26 individual PAIs, between the coach and the young participants. This paper takes on a narrative approach, emphasizing PAI as a narrative genre with its own particular characteristics, which sets the framework for a specific form of interaction (Bamberg, 2006). Results and Discussion The material display how eligibility is performed in interaction through different kinds of practices or acts of balance. One practice deals with balancing between praising the camp and the coaches without turning into flattery. Another practice deals with balancing between current deficiencies and possible progression, in order to appear as a 'subject under development' and therefore be perceived as selectable. This paper tells us a lot about PAI as genre, but also the discursive production of talent and eligibility in sports. References Anshell, MH, Lidor, R. (2012). Talent detection programs in sport: The questionable use of psychological measures. *Journal of sport behavior*. 35(3), 239-267. Bamberg, M. (2006). Stories: Big or Small? Why Do We Care? *Narrative Inquiry*. 16(1), 139-147. Helle-Valle, J. (2008). Discourses on Mass versus Elite Sport and Pre-adult Football in Norway. *International Review for the Sociology of Sport*. 43(4), 365-381. MacLean, J. C. (2001). *Performance Appraisal for Sport and Recreation Managers*. Illinois: NIRSA Education & Publication Center. McGarry, K. (2010). Sport in transition: Emerging trends on culture change in anthropology of Sport. *Review in Anthropology*. 39, 151-172. Peterson, T. (2011). Selektionssystem saknar talang [The systems for selection are lacking talent]. *Svensk idrottsforskning*. 4, 9-12.

## **URBAN LIVING ENVIRONMENTS AND CHILDREN'S PHYSICAL ACTIVITY. RESULTS OF A PILOT STUDY.**

Knechtl, S., Giess-Stueber, P.

*University of Freiburg, Institute of Sport Science*

Introduction Urban spaces are an important determinant of physical activity and behavior. Space is not solely a physical-material container; it is generated, confirmed, and changed by cultural, social, and individual action and design (Löw, 2008). In the appropriation of space, children's social life situation, corporeality, subjective, situation-related interests, and the structures of society play a major role. Thus, urban social spaces enable the experience of places, PA, and encounters with the unknown (Graumann, 2002) as well as promoting active and healthy lifestyles. The pilot study focused on method development for the research on the connection of urban space and children's PA (Spatscheck & Wolf-Ostermann, 2009). Methods The needle-method (Deinet, 2009) was modified and conducted at three German schools (n=31, 16♀/15♂; 10-15ys). Participants specified individually frequented or avoided locations on a city map by marking them with colored needles (according to gender, places, homes). The comments and conversations were recorded, transliterated, analyzed and combined with the marked locations. Results Results show differences between gender and age in mobility and PA. Boys mostly quoted PA as their leisure time activity, while girls were scarcely physically active. Former marked places in broader distances, whereas girls mostly marked their homes. The majority commuted to school via public transport, only a few travelled to school actively. Also, a number of statements were given concerning avoided and scary spaces, hampering PA. Discussion The findings confirm and differentiate established assumptions on the utilization of public space in gender research. The applied method proves to enable the identification of children's habits, preferences and also phobia regarding the utilization of urban space. Next, objective data (e.g. collection of area maps/GIS) and subjective data (e.g. cognitive maps, observations, interviews) will be gathered and intermingled.

**10:20 - 11:50****Invited symposia****IS-PM12 THE IMPACT OF PHYSICAL ACTIVITY ON CARDIOVASCULAR FUNCTION IN LIFESTYLE RELATED DISEASE \*****PHYSICAL ACTIVITY AND CARDIOVASCULAR DISEASE IN YOUNG PEOPLE: CAN CVD BE PREVENTED IN HIGH RISK POPULATIONS?**

Green, D.J.

*The University of Western Australia*

Rapid increases in the prevalence of obesity, type 2 diabetes, inactivity and sedentary behaviour in young people may limit future gains in the fight against cardiovascular disease, the major causes of mortality, morbidity and healthcare costs in the Western world.<sup>1</sup> Currently, 50% of adults who die suddenly from heart disease have no prior symptoms and 70% of coronary events occur as a result of culprit lesions that are angiographically undetectable.<sup>2</sup> Approaches to detection (angiography, stress testing) focus on ischaemia, not atherosclerosis, a disease of the vessel wall that only occasionally encroaches on the lumen.<sup>3</sup> Whilst these facts emphasise the importance of early prevention, and recent studies suggest that 80% of heart attacks may be preventable,<sup>4</sup> research focusing on optimal approaches to prevention remains a cardiovascular "blind-spot".<sup>5</sup> The evidence-base to establish early intervention targets for the prevention of future cardiovascular disease is not well established and the relative importance of the fetal environment, in relation to risk factor exposure during childhood and adolescence, is unclear. This symposium report will review the evidence for atherosclerosis as an important, if nascent, disease of young people, developmental studies of the antecedents factors that place adults at high risk and evidence regarding the mitigating impact of exercise interventions on macro and microvascular function and health in high risk children and adolescents. References 1. Olshansky SJ, et al. A potential decline in life expectancy in the united states in the 21st century. *NEJM*. 2005;352; 2. Fox C, et al. Temporal trends in coronary heart disease mortality and sudden cardiac death from 1950 to 1999: The framingham heart study. *Circulation*. 2004;110; 3. Harper RW, et al. A new algorithm for the management of stable coronary artery disease incorporating ct coronary angiography and fractional flow reserve: How we can improve outcomes and reduce costs. *MJA*. 2011;194; 4. Akesson A, et al. Low risk diet and lifestyle habits in the primary prevention of myocardial infarction in men: A populationbased prospective cohort study. *J Am Coll Cardiol*. 2014;64; 5. Mandrola JM. Cardiology's top 10 stories of 2014: Back-to-basics. *theHeart.org* Editorial. 2014;<http://www.medscape.com/viewarticle/836316>;

**THE INFLUENCE OF PHYSICAL ACTIVITY ON VASCULAR FUNCTION IN LIFESTYLE RELATED DISEASE**

Hellsten, Y.

*University of Copenhagen*

Life style related diseases, such as essential hypertension and Type II diabetes, are associated with impaired vascular function as evidenced by a poor vasodilator response to mechanical and chemical stimuli. Poor vascular control in skeletal muscle can result in an inadequate oxygen supply, limiting the ability to conduct daily activities, but has also implications for total peripheral vascular resistance and increases in blood pressure. Regular physical activity is well known to improve vascular function in several organs including skeletal muscle and to effectively reduce blood pressure. Both exercise of moderate and high intensity have been shown to be effective in this regard. This talk addresses the effect of physical activity interventions on changes in vascular function and the regulation of vascular tone and discusses the functional and cellular changes that occur in the vasculature with regular physical activity. An important factor in the regulation of vascular tone is the balance between, on one hand, vasoconstricting sympathetic activity and circulating vasoconstrictors such as endothelin-1, and, on the other hand, locally formed vasodilators, e.g. nitric oxide (NO) and prostacyclin. Evidence suggest that one of the beneficial effects of exercise training is an enhanced capacity to form vasodilators and a reduced presence of vasoconstrictors, leading to an improvement in the vasodilator to vasoconstrictor balance.

**FUNCTIONAL SYMPATHOLYSIS AS A CAUSE OF REDUCED SKELETAL MUSCLE BLOOD FLOW IN CARDIOVASCULAR DISEASE AND THE ROLE OF PHYSICAL ACTIVITY**

Mortensen, S.

*University of Southern Denmark*

Skeletal muscle can modulate sympathetic vasoconstrictor activity (functional sympatholysis) in young, healthy individuals. This mechanism is thought to play an important role in securing that O<sub>2</sub> delivery is sufficient to match the metabolic demand and is likely to be mediated by locally released substances that modulate the effect of noradrenaline on the alpha adrenergic-receptor. Several cardiovascular disease states are characterized by increased levels of sympathetic vasoconstrictor activity as well as impaired O<sub>2</sub> delivery leading to a reduced tissue function and early fatigue, but the role of functional sympatholysis in this malperfusion remains largely unexplored. Sedentary individuals with essential hypertension have impaired functional sympatholysis. The ability to induce functional sympatholysis is tightly coupled to the training status of the skeletal muscle and exercise training improves functional sympatholysis in individuals with essential hypertension, whereas inactivity impairs functional sympatholysis. Improving functional sympatholysis by exercise training could therefore be important to normalize skeletal muscle perfusion and function.

## Invited symposia

### IS-PM01 SPORTS NUTRITION EXCHANGE: ADVANCES IN THE APPLICATION OF SCIENCE IN THE SPORTING ENVIRONMENT sponsored by GSSI

#### TRANSLATING SUBSTRATE METABOLISM SCIENCE AND APPLYING IT IN THE ELITE SPORTING ENVIRONMENT

Spriet, L.L.

*University of Guelph*

Our current understanding of substrate metabolism has been driven by whole body and organ specific studies in a variety of animal models, including the human being. The most precise information on the capacity and regulation of energy provision in skeletal muscle via substrate and oxidative phosphorylation comes from invasive experiments during exercise. In the human, these are normally performed on recreationally active or sub-elite individuals and not on elite athletes. However, we use this information to guide training and competition nutritional strategies. The assumption is that most elite athletes have maximized their training, nutritional and rest strategies and adaptations in preparation for competition. The storage and delivery of fuel are maximized, the capacities and rates of metabolic energy pathways are maximized, the recovery of these systems between bouts of exercise are maximized and best performances are achieved. However, in elite athletes this is not enough and for many sports or athletic endeavours, it is clear that the human body is not optimally designed to achieve greater performances. So, we experiment further - does increasing oxygen provision increase oxidative energy provision and performance, does training with low carbohydrate or following a high fat diet lead to greater adaptations, can we augment substrate phosphorylation through creatine supplementation and enhanced buffering, does amino acid consumption enhance muscle function, does consuming nitrates reduce the cost of performance, do novel nutritional and training techniques increase muscle mass gain, etc.? Information gained from non-elite athletes can be applied to elite athletes without invasive measures and disruption to training, but positive findings in recreationally trained subjects and sub-elite athletes are not always seen in elite athletes.

#### NEW LESSONS IN THE REGULATION OF FAT METABOLISM AND IMPLICATIONS FOR ATHLETES.

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Lipids serve several important functions in the organism like structural components of cell membranes, in cellular signaling, and represent the largest storage pool for energy. The contribution of lipids to the total energy utilized during exercise is dependent on a variety of factors including exercise duration and intensity. The maximal contribution of lipids as energy substrate is reached at approximately 60-65% of maximal oxygen uptake. Furthermore, the use of FA for energy gradually increases during prolonged exercise when exercise lasts for more than 1-1½ h. It is also worth noticing that a higher FA oxidation is often observed in endurance trained females during prolonged exercise at moderate exercise intensities (60-65%) than in well matched male subjects. This is likely due to the on average higher percentage of type I muscle fibres and higher capillarization in females than males. How lipid oxidation is regulated during exercise is still under debate. Several possibilities have been proposed. The transport across the plasma membrane and thus the lipid binding proteins located in the membrane has been discussed playing a role in regulation of FA oxidation. CD36 is one of the plasma-membrane bound proteins, which might play a role in lipid handling during exercise. When CD36 is deleted in mice, the contraction induced increase in lipid uptake into the muscle, is absent. Also when AMPK, a fuel sensor, is lacking, CD36 protein content is decreased and so is the fatty acid uptake and oxidation. Together this indicates that transport of fatty acids into the muscle cell during exercise, when fuel for energy is needed, is an important step in fatty acid oxidation, though it might not be rate limiting. Rather, regulation around the mitochondria seems to be the more important step. Many athletes are concerned with either attaining or maintaining an optimal body weight and body composition for their sport. This leads to efforts to reduce body fat without losing muscle mass. A ketogenic diet has been proposed for athletes as a weight loss strategy without impairing strength and performance. A ketogenic diet comprises a fairly high protein intake, a very low carbohydrate intake and a large amount of fat. It is evident from the literature that an increased fat availability transfers into higher rates of both whole-body and muscle lipid utilization during standardized submaximal aerobic exercise. However, even in the face of substantially greater rates of fat oxidation, these dietary protocols consistently fail to improve endurance exercise capacity and/or performance outcomes compared with when consuming a carbohydrate-rich diet. With regard to the effect of a KD on strength performance, our knowledge is limited.

#### NOVEL REGULATORY MECHANISMS IN THE REGULATION OF GLUCOSE METABOLISM AND POTENTIAL INNOVATIVE NUTRITION STRATEGIES FOR ATHLETES.

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During exercise, muscle utilizes glucose taken up from the blood. The molecular mechanisms responsible involve several signalling pathways including AMP activated protein kinase (AMPK) and the GTPase Rac1 (1-3). Endurance training leads to higher muscle cell content of the glucose transporter GLUT4, but at the same absolute submaximal exercise intensity, trained individuals display lower muscle glucose uptake than untrained. Yet, at high exercise intensities, trained subjects utilize their greater GLUT4 muscle content and display higher muscle glucose uptake than untrained individuals. Rac1 is an important regulator of exercise-induced muscle glucose uptake by regulating GLUT4 translocation to the cell membrane. It is also known, that stretch of muscles increases muscle glucose uptake, and we have recently shown that stretch-induced muscle glucose uptake is partly dependent upon Rac1. Since muscle glucose uptake is important for glycogen resynthesis following exercise, a translational perspective from this finding is that stretching of muscles may enhance post-exercise glycogen resynthesis. Still, in the post-exercise period, muscle glycogen resynthesis is enhanced primarily due to increased sensitivity to insulin due to combined increased insulin signalling in the muscles and increased microvascular flow. Reference List 1. Sylow, L, Moller, LL, Kleinert, M, Richter, EA, Jensen, TE: Stretch-stimulated glucose transport in skeletal muscle is regulated by Rac1. *J Physiol* 593:645-656, 2015 2. Jensen, TE, Sylow, L, Rose, AJ, Madsen, AB, Angin, Y, Maarbjerg, SJ, Richter, EA: Contraction-stimulated glucose transport in muscle is controlled by AMPK and mechanical stress but not sarcoplasmic reticulum Ca(2+) release. *Mol Metab* 3:742-753, 2014 3. Sylow, L, Jensen, TE, Kleinert, M, Moutatt, JR, Maarbjerg, SJ, Jeppesen, J, Prats, C, Chiu, TT, Boguslavsky, S, Klip, A, Schjerling, P, Richter, EA: Rac1 is a novel regulator of contraction-stimulated glucose uptake in skeletal muscle. *Diabetes* 62:1139-1151, 2013

## Oral presentations

### OP-PM07 Carbohydrate and Performance

#### CARBOHYDRATE DEPENDENCE DURING HALF-MARATHON RUNNING

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**Introduction** Many athletes and coaches steadfastly believe that fat plays an important role while training for and competing in endurance events and that training and/or nutritional strategies that “spare” carbohydrate-based fuels and enhance the oxidation of fat-based fuels will improve exercise capacity. However, few studies have investigated substrate utilisation during prolonged, intense exercise. This study tested the hypothesis that carbohydrate is the major fuel source during prolonged intense running. We also determined the effect of suppressing lipolysis on rates of whole-body substrate utilisation and performance in well-trained individuals during simulated half-marathon races. **Method** Six (of 12) well-trained male runners ( $\text{VO}_2\text{max}$   $63.9 \pm 4.6$  mL/kg/min, personal best half-marathon  $80.13 \pm 5.10$  min) completed 4 experimental trials using a single-blinded Latin square design. Subjects ran to volitional fatigue on a motorised treadmill at a speed of 95% of individual best half-marathon (21.1 km) time attained in the last 6 months, and a gradient of 1%. The 4 experimental conditions were a carbohydrate breakfast (CHO), a carbohydrate breakfast plus Nicotinic acid (CHO+NA), an overnight fast (FAST), an overnight fast plus Nicotinic acid (FAST+NA). Carbohydrate gels (44 g/h) were provided during the CHO and CHO+NA trials. **Results** There was no effect of diet or NA ingestion between conditions for distance covered (CHO  $21.82 \pm 1.40$ , CHO+NA  $21.51 \pm 2.25$ , FAST  $20.77 \pm 2.56$ , FAST+NA  $20.13 \pm 1.09$  km). Total rates of carbohydrate oxidation were unaffected by diet or NA (CHO  $323.80 \pm 26.05$ , CHO+NA  $332.2 \pm 25.09$ , FAST  $313 \pm 18.54$ , FAST+NA  $330.32 \pm 31.45$   $\mu\text{mol/kg/min}$ ). Carbohydrate was the primary fuel source for oxidative metabolism, contributing 81-87% to total energy expenditure. No significant difference for diet or NA was reported for heart rate, rate of perceived exertion or loss in body mass between the 4 performance trials. **Discussion** During prolonged, intense running (~80%  $\text{VO}_2\text{max}$ ) carbohydrate was the major fuel source for oxidative metabolism regardless of pre-exercise carbohydrate or fat availability. When carbohydrate availability is high, reducing free fatty acid availability was not detrimental to intense running performance. **Contact:** jill.leckey@acu.edu.au

#### A TWO WEEK LOW GLYCEMIC INDEX DIET AFFECTS METABOLIC PARAMETERS OF SPORT STUDENTS AT REST AND DURING EXERCISE WITHOUT AFFECTING ENDURANCE PERFORMANCE

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The glycemic index (GI) is an intensively discussed topic in sports nutrition, however the effects of single high glycemic index (HGI) or low glycemic index (LGI) meals on metabolic or performance outcomes are still controversially discussed. Regarding single pre-exercise meals, LGI food has been postulated to enhance endurance capacity because of a higher fat oxidation rate and thus reducing carbohydrate (CHO) storage decline during exercise. Long term LGI diets are an important issue in health related studies with patients, but no study compared the more chronic effects of a HGI or LGI diet in athletes so far. **Aim** of the present study was to investigate the combined effects of a two week diet with CHO of either LGI or HGI and a single LGI test meal on endurance capacity and metabolic parameters 90 min after the LGI test meal. 19 young and healthy sport students (14 male and 5 female; age:  $25.8 \pm 3.2$  years; body mass:  $73.1 \pm 11.8$  kg; height:  $178.0 \pm 8.5$  cm;  $\text{VO}_2\text{max}$ :  $52.3 \pm 6.4$  mL $\cdot$ kg $^{-1}$  $\cdot$ min $^{-1}$ ) completed four trial days separated by at least two weeks wash-out in a randomized crossover design, one on the day before and one on the last day of 14 days LGI and HGI intervention, respectively. Based on the information of a four day food diary, the two different dietary schedules were calculated for each subject by exchanging specific foods from their normal diet resulting in either HGI diet with a  $\text{GI} > 70$ , or LGI diet with a  $\text{GI} < 50$ , respectively. The mean GI was calculated for each meal. The trial days started with a venous blood sampling followed by an identical LGI test meal containing 2 g CHO per kg body weight ( $\text{GI} = 40$ ) after an overnight fast (12 h). 90 min postprandial (PP) the participants ran 60 min at 65%  $\text{VO}_2\text{max}$  and subsequently at 95%  $\text{VO}_2\text{max}$  until exhaustion. Body weight was lower after the LGI- compared to the HGI-intervention (LGI:  $72.8 \pm 12.3$  kg, HGI:  $74.0 \pm 12.5$  kg,  $p < 0.05$ ). PP rest and exercise respiratory quotients became lower in LGI- compared to HGI-intervention (PP: LGI:  $0.85 \pm 0.05$ , HGI:  $0.88 \pm 0.04$ ; exercise: LGI:  $0.89 \pm 0.02$ , HGI:  $0.91 \pm 0.03$ ,  $p < 0.05$ ). Triglyceride values were lower after LGI compared to HGI (LGI:  $0.85 \pm 0.30$  mmol/L, HGI:  $1.09 \pm 0.50$  mmol/L,  $p < 0.05$ ). Blood lactate rest values were lower in LGI compared to HGI after ingestion of the test meal ( $p < 0.05$ ) without any differences during exercise. Endurance capacity and parameters of glucose metabolism remained unaffected. To summarize, a two week LGI diet in combination with a single LGI test meal reduced body weight and triglycerides and caused a shift from CHO to fat oxidation at rest and during exercise without effects on glucose metabolism or performance.

#### CARBOHYDRATE SUPPLEMENTATION DOES NOT IMPROVE A 10 KM SWIM PERFORMANCE

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**Introduction** For exercise lasting more than 2h, it is well established that carbohydrate (CHO) ingestion during exercise can improve exercise performance by preventing hypoglycemia, maintaining high rates of CHO oxidation and therefore increasing endurance capacity (Jeukendrup 2014). While most research focused on running and cycling, there is a lack of studies focusing on open water endurance swimming. Therefore, the aim of the present study was to evaluate the effects of the ingestion 60 g $\cdot$ h $^{-1}$  of carbohydrates on a 10km swim performance. Moreover, the present study represents the first attempt to monitor glycemia continuously during an endurance swimming event. **Methods** Ten elite open-water swimmers (6 male and 4 female;  $22 \pm 5$  yrs,  $1.76 \pm 0.05$  m,  $70.5 \pm 7$  kg) volunteered for the present study. In two difference occasions in a random order, they were asked to perform a 10km swim (20x500m) in a 25m indoor pool, ingesting every 2.5km either water (WAT) or a solution of water and 60 g $\cdot$ h $^{-1}$  of CHO. Every 1000m athletes had to rate their perceived exertion (RPE) on the 6-20 scale. Glycemia was monitored throughout the test with continuous glucose monitoring (CGM) (iPro 2, Medtronic). A two-way ANOVA was used to analyze the effect of trial on parameter time course ( $p < 0.05$ ). **Results** Performance was not different between the two trials (1:54:26 $\pm$ 0:04:09 h:m:sec CHO; 1:54:27 $\pm$ 0:04:26 h:m:sec WAT). RPE increased significantly throughout both trials, with no differences between CHO or WAT. No signs of hypoglycemia were found during the WAT trial. Glycemia increased the last 3km of the CHO trial (107.5 $\pm$ 7.7; 113.0 $\pm$ 7.0; 118.7 $\pm$ 9.1 mg $\cdot$ dl $^{-1}$ ) and was significantly higher compared to the same time points in the WAT trial (101.4 $\pm$ 11.4;

104.3±12.5; 105.8±13.8 mg.dl<sup>-1</sup>). Discussion Open water events longer than 5-km may be considered glycogen depleting (Costill et al. 1988). However, supplementation with 60 g.h<sup>-1</sup> of CHO did not increase a simulated 10 km swimming performance or influence RPE in elite swimmers. Although this represents the first analysis in continuum of glycemia in elite endurance swimmers, which suggests that 10km swimming at a racing pace does not lead to hypoglycemia, the need and/or effectiveness of CHO supplementation on endurance performance in open water should be further explored. References Jeukendrup A. (2014). *Sports Medicine*, 44(Suppl 1):S25–S33 Costill et al 1988. *J. Swimming Research*. 4, 15–18

### THE ACTIVATION OF ADENOSINE RECEPTORS INHIBITED CAFFEINE-AFFECTED EXERCISE PERFORMANCE, THERMOREGULATION AND BRAIN NEUROTRANSMISSION

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**Introduction** Caffeine (CAF) is widely consumed to improve exercise performance. However, this mechanism remains elusive. Recently, we reported that CAF improved endurance exercise performance, overrode the critical level of core body temperature (T<sub>core</sub>), and increased extracellular dopamine (DA) release in the preoptic area and anterior hypothalamus (PO/AH) in exercising rats (Zheng et al., 2014). We also found that blockage of dopaminergic pathways inhibited CAF-affected exercise performance, hyperthermia and DA release in the PO/AH (Zheng & Hasegawa, 2014). However, it's difficult to conclude that CAF-improved exercise performance is due to blockage of brain adenosine receptors. The purpose of this study was to examine the effects of an adenosine receptor agonist on CAF-affected thermoregulation, neurotransmitter release, and endurance exercise performance. **Methods** T<sub>core</sub>, tail skin temperature (T<sub>tail</sub>: an index of heat loss), oxygen consumption (VO<sub>2</sub>: an index of heat production), DA, noradrenaline (NA) and serotonin (5-HT) were measured. One hour before the start of exercise, rats were intraperitoneally injected with either saline, 10 mg/kg of CAF, a non-selected adenosine receptor agonist NECA (0.5 mg/kg) or the combination of CAF and NECA. Rats ran until fatigue on the treadmill with a 5% grade at a speed of 18 m min<sup>-1</sup> at 23°C. **Results** The run time to fatigue (RTTF) was significantly increased by the administration of CAF and decreased by the injection of NECA (SAL: 91 ± 14 min; CAF: 130 ± 23 min; NECA: 31 ± 14 min; CAF+NECA: 87 ± 16 min, p < 0.05). In addition, injection of CAF inhibited NECA-induced decrease in RTTF, T<sub>core</sub>, VO<sub>2</sub>, T<sub>tail</sub>, and extracellular DA release. Neither CAF nor NECA affected extracellular NA or 5-HT release. **Discussion** Consistent with Davis et al. (2003), we observed that NECA inhibited CAF-increased RTTF in the present study. Moreover, it has been shown that decreased brain DA release inhibits both improved exercise performance and overridden the critical T<sub>core</sub> caused by CAF (Zheng & Hasegawa, 2014). In the present study, we observed that NECA inhibited CAF-increased DA release in the PO/AH, and overridden the critical T<sub>core</sub>. One possible mechanism of CAF's ergogenic effect is CAF blocks increased adenosine receptors, increases DA release in the PO/AH, improves heat tolerance and overrides the critical level of T<sub>core</sub>. Our results elaborate on both the improved endurance performance and the overridden body limitation caused by CAF are reliable, and the ergogenic effects of CAF may be due to blockage of adenosine receptors increased brain DA release. References Davis et al. (2003). *Am J Physiol Regul Integr Com Physiol*, 284, 399-404. Zheng et al. (2014). *Pharmacol Biochem Behav*, 122, 136-43. Zheng, Hasegawa (2014). Proceeding of the 19th ECSS. Do not insert authors here

### THE EFFECT OF AN 8-DAY CYCLING TOUR ON PERFORMANCE, HEART RATE AND POMS IN 30 RECREATIONAL CYCLISTS

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**INTRODUCTION** Between 10-35% of athletes face at least one episode of non-functional overreaching (NFOR) or the overtraining syndrome (OTS) throughout their career. Athletes with NFOR/OTS often suffer from psychological and physical symptoms, which only rest can restore. Therefore, the prevention and early diagnosis of NFOR/OTS is of utmost importance. A multistage cycling tour such as Tour for Life (TfL; an 8-day fundraising bicycle tour, 1264 km with 18.550 altitude meters) provides an excellent, ecological, experimental model to study intensified training possibly leading to NFOR/OTS. Participants are well-trained cyclists but unfamiliar with this magnitude of exercise. The aim of this part of the study is to monitor the effect of an 8-day cycling tour on performance, maximal heart rate and Profile of Mood State (POMS). **METHODS** 30 recreational cyclists (19 male; 11 female) with an average age of 41y, BMI of 23.6 kg/m<sup>2</sup>, and self-reported training volume in preparation for the TfL of 190 km per week (range 75-300 km) were included in the study. The TfL was on average a 7-fold increase of the training volume. Peak power output (W) and maximal heart rate (bpm) were measured in a double exercise test before, immediately after, and 5 weeks after the TfL. Additionally, subjects filled in a POMS questionnaire before, during and after the TfL. **RESULTS** On group level the participants performed significantly (p<.01) worse on the post-TfL exercise test (320±57 W) than pre-TfL (308±60 W). Only 6 subjects performed better after the TfL than at baseline. Also, maximal heart rate was significantly (p=.02) lower after the TfL (pre: 181±10 bpm, post: 176±11 bpm). Analysis of the POMS questionnaire revealed that fatigue increased more during (72%) than after (44%) the TfL compared with baseline. Tension decreased during (-26%) and after (-32%) TfL, while anger increased during (21%) the TfL and returned to baseline values after the event. **DISCUSSION** In this study we were able to demonstrate decreased performance and maximal heart rate, and alterations in mood states after the TfL. However, it is important to note that these results are all on group level. Further analyses will focus on the individual response of the participants on the cycling event. Moreover, other measurements performed in this study (e.g. physiological, biochemical, immunological, psychological) will be studied together and related to the individual performance changes. **CONTACT** tpg.ten.haaf@vu.nl

### INGESTION OF GLUCOSE OR SUCROSE DURING PROLONGED ENDURANCE TYPE EXERCISE PREVENTS A DECLINE IN LIVER BUT NOT MUSCLE GLYCOGEN CONCENTRATION

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**Introduction** Carbohydrate (CHO) ingestion during prolonged exercise enhances performance, increases CHO oxidation and may spare muscle glycogen stores (Cermak and van Loon, 2013). Few data are available on the impact of CHO ingestion on liver glycogen stores. When trying to maximize CHO availability during exercise, it may be preferred to ingest a combination of different carbohydrate sources

eg. glucose (GLU) and fructose. As sucrose (SUC) provides both glucose and fructose, we hypothesize that sucrose ingestion during exercise may allow greater carbohydrate uptake, resulting in greater sparing of liver and/or muscle glycogen stores when compared to the ingestion of glucose only. Methods Fourteen cyclists ( $VO_{2peak}$ :  $58 \pm 1$  mL/kg/min) completed two 3-h bouts of cycling at 50%  $W_{max}$  while ingesting either GLU or SUC at a rate of 1.7 g/min. Four cyclists ( $VO_{2peak}$ :  $60 \pm 3$  mL/kg/min) performed a third test in which only water was consumed for reference. We used  $^{13}C$  magnetic resonance spectroscopy to determine liver and muscle glycogen concentrations before and after exercise. Expired breath was sampled during exercise to estimate whole-body substrate use. All data are means  $\pm$  SEM. Pre- vs post-exercise liver and muscle glycogen concentrations in the water trial were compared by paired *t* tests. Liver and muscle glycogen concentrations in the GLU and SUC treatments were assessed by two-way (treatment  $\times$  time), repeated measures ANOVA with treatment (GLU vs SUC) and time (pre- vs post-exercise) as within-subject factors. Results Both liver (from  $454 \pm 17$  to  $283 \pm 41$  mmol/L;  $P < 0.05$ ) and muscle (from  $111 \pm 23$  to  $67 \pm 15$  mmol/L;  $P < 0.01$ ) glycogen concentrations declined during exercise when only water was ingested. Following GLU and SUC ingestion, liver glycogen levels did not show a significant decline following exercise (from  $325 \pm 45$  to  $345 \pm 55$  mmol/L and from  $321 \pm 47$  to  $348 \pm 56$  mmol/L, respectively;  $P > 0.05$ ) with no differences between treatments. Muscle glycogen concentrations declined (from  $101 \pm 11$  to  $60 \pm 9$  mmol/L and from  $114 \pm 13$  to  $67 \pm 9$  mmol/L, respectively;  $P < 0.05$ ), with no differences between treatments. Whole-body CHO utilization was greater with SUC ( $2.03 \pm 0.11$  g/min) vs GLU ( $1.66 \pm 0.10$  g/min;  $P < 0.05$ ). Discussion Ingestion of glucose or sucrose (1.7 g/min) during prolonged exercise prevents a decline in liver but not muscle glycogen concentrations. Sucrose ingestion during prolonged exercise does not lead to greater sparing of endogenous muscle or liver glycogen stores when compared to glucose ingestion. References Cermak NM, van Loon, LJ (2013). *Sports Med*, 43: 1139. Contact jg833@bath.ac.uk

## Oral presentations

### OP-PM04 Adaptation and Movement Analysis

#### SPRINT INTERVAL TRAINING OF ARMS AND LEGS ELEVATES PEAK VO<sub>2</sub> AND IMPROVES ARM EXERCISE ECONOMY

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1: Swedish Winter Sports Research Centre, Department of Health Sciences, Mid Sweden University, Östersund, Sweden 2: Department of Sport Science, Julius Maximilians University Würzburg, Germany 3: Department of Physical Education, University of Las Palmas de Gran Canaria, Spain 4: Swedish School of Sport and Health Sciences, Stockholm, Sweden 5: Department of Physiology and Pharmacology, Karolinska Institute, Stockholm, Sweden 6: Institute of Sports Science and Clinical Biomechanics, SDU Muscle Research Cluster, University of Southern Denmark, Odense, Denmark Introduction Interval cycle sprint training (SIT) has been shown to improve anaerobic capacity,  $VO_{2max}$  and biomarkers of muscle oxidative capacity in as little as 2 weeks in previously untrained adults. The present study was designed to characterize and compare systemic  $VO_2$  and exercise performance after SIT engaging the arms and legs. Methods Sixteen healthy, untrained men ( $23.9 \pm 3.7$  yrs;  $183.8 \pm 6.8$  cm;  $80.3 \pm 14.1$  kg) performed six sessions of 4-6x30 sec all-out sprints with the legs then arms (or vice versa) separated by a 1-h recovery over an 11-day period. Limb-specific  $VO_{2peak}$ , anaerobic capacity (2x30-sec Wingate tests with 4 min of recovery), a 4-min submaximal work economy test, and a 5-min all-out time trial (TT) were conducted before and after the training program. Muscle biopsies (from the m. vastus lateralis and m. triceps brachii) were taken before and after the training period. Results  $VO_{2peak}$  increased by 10.6% and 5.9% with arm and leg training, respectively ( $p < 0.05$ ), with the increase in the arms significantly greater than in the legs ( $p = 0.02$ ). Work economy was improved for the arms (-9.8%,  $p < 0.05$ ), but not for the legs (-0.9%). Mean power during the TT rose by 13.5% for the arms and 11.8% for the legs ( $p < 0.05$ ). Peak power output and mean power during the two Wingate tests were elevated in both the arms (PPO: 6.7% ( $p < 0.01$ ) and 13.3% ( $p < 0.01$ ); MPO: 6.1% ( $p < 0.01$ ) and 8.4% ( $p < 0.01$ )) and legs (PPO: 3.1% ( $p = 0.07$ ) and 7.1% ( $p = 0.02$ ); MPO: 3.3% ( $p < 0.01$ ) and 5.6% ( $p < 0.01$ )). The activity of 3-hydroxyacyl-CoA dehydrogenase (HAD) and levels of muscle glycogen were unchanged in both limbs. Discussion Sprint interval training with arm or leg cycling exercise increased peak pulmonary  $VO_2$  during their respective modes over an 11-day training period with a greater increase in the arms. Sprint performance rose to a similar extent in both extremities, yet work economy was improved only in the arms. These findings suggest some limb-specific responsiveness to SIT training. Contact Christoph.zinner@uni-wuerzburg.de

#### INDIVIDUAL RESPONSES TO A NOVEL EXERCISE INTERVENTION IN OLDER ADULTS WITH MULTIMORBIDITY: A PILOT RANDOMISED CONTROLLED TRIAL

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Introduction Individual differences in the response to exercise training are important, though quantification attempts are rare and often deficient (Hopkins, 2015). We aim to quantify mean and individual responses of older adults with multimorbidity to a novel exercise intervention. Methods 15 adults (14 male;  $71.8 \pm 6.2$  y [mean  $\pm$  standard deviation, SD]) with multimorbidity were randomised to intervention ( $n = 7$ ) and control ( $n = 8$ ). The intervention was four sets of 4-min high-intensity exercise with 3-min rest between, thrice-weekly for six weeks. Exercises (squat, clean/press, step-up/press) were performed on a double-concentric device. Outcomes were anaerobic threshold (AT) and peak oxygen uptake ( $VO_{2peak}$ ). Using a linear mixed model with a random effect allowing extra variance in the change scores in the intervention group, we calculated the probability that the true population effect was  $>$  the minimum clinically important difference (MCID, 1.5 mL.kg.min<sup>-1</sup> and 2 mL.kg.min<sup>-1</sup> for AT and  $VO_{2peak}$ , respectively). The model was adjusted for baseline value of the outcome and age. We derived the SD for individual differences in response to the intervention (vs control). We calculated the likely range for the true response (free from noise) in each subject in the intervention group using the SD of the change in the controls, and obtained the probability that the subject was a true responder (improvement  $>$  MCID) (Hopkins, 2015). This novel method identifies responders by accounting for variability in the change scores in the control group rather than inappropriately using the change scores from the intervention group alone. Results A likely beneficial increase for AT of 3.2 mL.kg.min<sup>-1</sup> (90% confidence interval -0.1 to 6.5 mL.kg.min<sup>-1</sup>), and a possibly beneficial increase for  $VO_{2peak}$  of 3.2 mL.kg.min<sup>-1</sup> (-0.1 to 6.5 mL.kg.min<sup>-1</sup>) was observed in the intervention group compared to

controls. The SD of the individual responses was very large for AT (3.8 ml.kg.min<sup>-1</sup> [-1.7 to 5.7 ml.kg.min<sup>-1</sup>]), and large for VO<sub>2</sub>peak (2.9 ml.kg.min<sup>-1</sup> [-2.6 to 4.8 ml.kg.min<sup>-1</sup>]). For AT, two subjects were almost certainly responders, two were likely, one was possibly, and two were probably not. For VO<sub>2</sub>peak, one subject almost certainly responded, two likely, three possibly and one probably not. Discussion Six weeks of high-intensity exercise induces likely-possible improvements in AT and VO<sub>2</sub>peak in older adults with multimorbidity, with apparently substantial individual responses. A definitive trial is required to confirm and explain these effects. References Hopkins, WG (2015). *J Appl Physiol*, In press.

### **DISCRIMINANT MUSCULO-SKELETAL LEG CHARACTERISTICS BETWEEN ELITE CAUCASIAN SPRINT AND ENDURANCE RUNNERS.**

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*University Ghent*

**Aim** The question whether a runner is more suited for sprint vs. endurance disciplines and whether he/she has the talent to reach national or even international top level, depends in part on the musculo-skeletal characteristics of the legs. The main limiting factor for sprinting is power generation, which is directly related to muscle volume and fascicle length. On the other hand, endurance running requires excellent running economy, which is in part negatively influenced by inertia of the legs during swing phase (Weyand & Davis, 2005). This study aims to directly compare the physiological and functional anatomical characteristics of the leg of male sprinters and endurance runners of Caucasian ethnicity in order to discover the largest discriminants. **Methods** Eight male sprinters (60m - 200m) and 11 male endurance runners (3000m – 5000m) volunteered to participate in this cross-sectional study. Personal best performances ranged between 6.95 and 7.07 sec for 60m or 10.68 and 10.99 sec for 100m in sprinters and 7.54 and 8.53 min for 3000m or 13.32 and 14.55 min for 5000m in endurance runners. They underwent magnetic resonance imaging (MRI) from the iliac crest to the calcaneus. After data collection, the MR images were transferred to 3D slicer for digital reconstruction to calculate muscle volumes and bone lengths. Ultrasonography was used to determine muscle architecture (pennation angle and fascicle length). **Results** Sprinters have a higher total upper leg volume compared to endurance runners (7340 vs. 6265 cm<sup>3</sup>, P = 0.020). Specifically, the rectus femoris, vastus lateralis and hamstrings showed significantly higher muscle volumes in the sprint group. For the lower leg, only a higher muscle volume was found in the gastrocnemius lateralis for the sprinters (206 vs. 170 cm<sup>3</sup>, P = 0.017). No differences were found in muscle volume distribution, center of mass in the different muscles, pennation angle or fascicle length, nor relative bone lengths. There was a significant positive correlation between ratio hamstrings/quadriceps volume and best running performance in the sprint group (R = 0.811, P = 0.015). **Conclusions** The main discriminants among the musculo-skeletal leg characteristics between sprinters and endurance runners of the same ethnicity (Caucasian) are situated in muscle volumes, rather than muscle orientation or skeletal measures. Sprinters show higher volumes in mainly the proximal and lateral leg muscles than endurance runners. Our data support the notion that the hamstrings muscles are an important factor in sprint running performance. References Weyand, P. G., & Davis, J. A. (2005). Running performance has a structural basis. *The Journal of Experimental Biology*, 208, 2625–2631.

### **THE EFFECT OF HEAVY RESISTANCE TRAINING ON SKELETAL MUSCLE STRENGTH AND FUNCTION IN VERY OLD INDIVIDUALS**

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**Background:** The proportion of European citizens aged at least 65 years will increase from 18% in 2013 to around 28% in 2050. The skeletal muscle mass and –strength decrease with up to 2%/yr from the age of 50 and around half of the population above the age of 80 years cannot perform daily activities satisfactorily due to decreased muscle strength. This increases the need for personal care and strategies to keep the elderly self-reliant are demanded. The aim of this study is to investigate the effect of heavy resistance exercise on skeletal muscle strength and mass in very old individuals. **Methods:** 30 subjects aged at least 83 years were randomized to 12 weeks of either heavy resistance training of the lower extremities three times weekly (HRT+PRO) or no exercise (PRO). Both groups were offered two daily nutrient supplementations each containing 1260kJ including 20g of milk protein. Before and after the intervention thigh power, isometric and isokinetic strength were measured. Further, blood samples, thigh MRI scans and m. vastus lateralis biopsies were obtained before and after intervention. **Results:** 28 subjects completed testing and 26 completed interventions as scheduled. Per-protocol analysis (two-way ANOVA with repeated measures) revealed interaction (P<0.05) and post-hoc gain in thigh power (17±5W / 15±8%), isometric (16±6Nm / 13±5%) and isokinetic (11±3Nm / 13±4%) strength in HRT+PRO respectively, whereas the PRO did not change (P=0.68). Rate of force development revealed interaction (P<0.05) and decreased 86±36Nm/s (16±7%) in PRO. Plasma cholesterol decreased (time, P<0.05) 0.7±0.2mM (14±4%). MRI- and biopsy results are pending. **Conclusion:** Heavy resistance training for 12 weeks improves muscle strength and power, and maintains rate of force development. Mixed nutrient supplementation with 20g of dairy protein improves plasma cholesterol. Due to the physical strain caused by the training, subjects' health, expected gain and risk of injuries have to be considered thoroughly before applying a training regime like this in the very old.

### **STRENGTH TRAINING IMPROVES CYCLING PERFORMANCE THROUGH IMPROVED FRACTIONAL UTILIZATION OF VO<sub>2</sub>MAX AND CYCLING ECONOMY**

Vikmoen, O.1, Rønnestad, B.R.1, Ellefsen, S.1, Raastad, T.2

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**Introduction** Heavy strength training (HST) of a sufficient volume and lasting 8 weeks or longer have been reported to improve cycling performance in trained cyclists (1,2,3). However, the mechanisms behind improved performance after HST is unclear. The objective of the current study was to investigate the mechanisms behind improved cycling performance after HST. **Methods** Nineteen well-trained female cyclists (33 ± 8 years, 64 ± 7 kg, VO<sub>2</sub>max: 54 ± 3 ml.kg<sup>-1</sup>.min<sup>-1</sup>) were randomly assigned to either normal endurance training only (E, n=8) or normal endurance training combined with HST (E+S, n=11). The HST consisted of lower body exercises [3 x 4-10 repetition maximum (RM)], performed twice a week for 11 weeks. Cycling performance was evaluated as mean power output during a 40 min all-out test. To investigate mechanisms behind changes in performance, 1RM, muscle cross sectional area (CSA), VO<sub>2</sub>max, cycling economy, and fractional utilization of VO<sub>2</sub>max was measured. In addition, muscle biopsies were taken from m. vastus lateralis. **Results** E+S increased 1RM in leg exercises (40 ± 15%, p = 0.0001) and quadriceps femoris CSA (7 ± 5%, p = 0.0004). E+S increased body mass adjusted power output during the 40 min all-out test (6 ± 8%, p = 0.002), cycling economy (4 ± 3%, p = 0.004) and fractional utilization of



VO<sub>2</sub>max (from  $79 \pm 3\%$  to  $82 \pm 4\%$ ,  $p = 0.05$ ). The proportion of type IIX muscle fibers in m. vastus lateralis was reduced in E+S from  $9 \pm 7\%$  to  $0\%$  ( $p = 0.005$ ) with an concomitant increase in type IIA fibers from  $39 \pm 13\%$  to  $51 \pm 10\%$  ( $p = 0.002$ ). The protein content of aerobic enzymes in m. vastus lateralis did not change in E+S. No changes occurred in E. The change in 40 min all-out performance correlated with change in the proportion of IIX fibers ( $r = -0.63$ ,  $p = 0.009$ ) and change in muscle CSA ( $r = 0.73$ ,  $p = 0.0004$ ). Discussion The main finding of this study was that adding HST improved cycling performance because of improved fractional utilization of VO<sub>2</sub>max and cycling economy in well-trained female cyclists. Physiological mechanisms behind these changes seemed to be a fiber type transition from type IIX to pure type IIA fibers and increased muscle CSA. Improved cycling economy and performance is in accordance to earlier studies (1,2,3) using similar HST interventions. This is the first study showing that improved fractional utilization of VO<sub>2</sub>max is one of the main mechanism behind improved performance after HST. Conclusion Based on these results trained cyclist should add HST to their normal training for maximal gains in cycling performance. References 1. Aagaard et al., *SJMSS*, 2011; 21:298-307 2. Rønnestad et al., *EJAP*, 2010; 108:965-975 3. Sunde et al., *JSCR*, 2010; 24:2157-2165 contact: olav.vikmoen@hil.no

## HIGH-INTENSITY MOVEMENTS IN ELITE TEAM HANDBALL: MATCH ANALYSIS

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Introduction High intensity movements have typically been recorded at high running velocities, and thereby do not take into account all accelerations or high intensity actions occurring at low speed (Varley & Aughey, 2013). High-intensity micro movements that are present in team handball match play are difficult to quantify using traditionally time motion analysis. This study aims to quantify the positional specific, high-intensity actions in elite women's team handball match play using accelerometers. Methods Player movements were observed from 16 players (backs, pivots, wings, and goal keepers (GK)) during six international matches of the Norwegian women's national team. Tracking devices (Catapult Optimeye S5, Australia) with 100 Hz accelerometer, magnetometer, and gyroscope were used for data collection. The devices were placed in a vest and were located on the upper back of all players. Efforts were measured and categorized into the following categories: acceleration, deceleration, change of direction (CoD), and jump. Efforts were divided into intensity zones of low (1.5 -2.5 m.s<sup>-1</sup>), medium (2.5-3.5 m.s<sup>-1</sup>), and high (> 3.5 m.s<sup>-1</sup>). Differences between positions were deemed likely when there was a likelihood of >75 % of the difference exceeding an effect size of 0.2. Results On average (mean  $\pm$  SD), when intensity zones were combined, team handball players accelerate  $1.6 \pm 0.8$  times per min, decelerate  $2.3 \pm 0.8$  times per min, execute a CoD  $8.9 \pm 3.2$  times per min, and jump  $0.3 \pm 0.2$  times per min in match play. The numbers of efforts performed in all categories were position dependent. Back players had the most accelerations per min ( $2.1 \pm 0.7$ ), which was likely different from wings ( $1.2 \pm 0.1$ ) and GK ( $0.38 \pm 0.1$ ), but not from pivots ( $1.8 \pm 0.3$ ). No differences were found between pivots and backs for decelerations (pivots:  $3.3 \pm 0.9$ , backs;  $3.0 \pm 0.5$ ) and CoD (pivots:  $10.9 \pm 2.6$ , backs:  $10.5 \pm 1.9$ ), but both were very likely to be different from wings (decelerations:  $1.73 \pm 0.3$ , CoD:  $8.51 \pm 1.5$ ) and GK (decelerations:  $0.91 \pm 0.2$ , CoD:  $3.0 \pm 0.4$ ). Back players performed most jumps per min ( $0.38 \pm 0.2$ ), very likely different from wings ( $0.22 \pm 0.1$ ), pivots ( $0.15 \pm 0.1$ ) and GK ( $0.1 \pm 0.1$ ). Discussion A high amount of high intensity actions in match play was shown, which has not previously been reported in team handball. These actions are important to acknowledge when designing training programs for team handball players. Furthermore, there are likely differences between the four different playing positions. Therefore, the positional differences in high-intensity movements should be accounted for when developing specific conditioning drills. References Varley, M., & Aughey, R. (2013). *International Journal of Sports Medicine*, 34, 33-39. Contact: Email: livesl@nih.no

## Invited symposia

### IS-BN10 LATERALITY IN LOCOMOTION AND SPORT SPONSORED BY ADIDAS

#### INTERLIMB TRANSFER OF LEARNED DYNAMICS

Stein, T.

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Motor learning is an essential function of the human nervous system that is still not fully understood. In literature, two distinct types of motor learning are discussed: skill learning and motor adaptation. Skill learning (e.g., learning to play tennis) involves the acquisition of new patterns of muscle activations and thereby achieving a higher level of performance (Shmuelof et al., 2012). In motor adaptation, the human motor system responds to new environmental conditions (e.g., the use of a new tennis racket) to regain the former level of performance (Shadmehr et al., 2010). In my talk I will focus on motor adaptation, which is most often studied in laboratory settings. Thereby, subjects most commonly adapt their reaching movements to either kinematic perturbations (visuomotor rotations or prism-induced displacements) or dynamic perturbations (robot-induced forces, rotations of the body or attached inertial loads) (Stockinger et al., 2014). What is typically observed in these adaptation tasks is that subjects' show initially – when exposed to the perturbation – large performance errors. However, subjects' performance improves rapid followed by a slower increase to steady state close to baseline performance (Shadmehr & Mussa-Ivaldi, 1994). Based on these classifications I will focus in my talk on the interlimb transfer of learned dynamics. Interlimb transfer refers to the generalization of motor skills across hands. In studies (e.g. Criscimagna-Hemminger et al., 2003; Wang & Sainburg, 2004; Joiner et al., 2013) on the interlimb transfer of learned dynamics, subjects usually adapt their reaching movements to a dynamic perturbation and are subsequently checked for transfer to the contralateral untrained arm. In my talk I will review and discuss experimental results on the following aspects: (1) the direction of interlimb transfer (e.g., bi- or unidirectional), (2) the coordinate frame of transfer (e.g., extrinsic versus intrinsic) and (3) interlimb transfer and consolidation (e.g., stabilization of the transfer). References Criscimagna-Hemminger, S.E. et al. (2003). *J Neurophysiol*, 89, 168-176. Joiner et al. (2013). *J Neurophysiol*, 110, 984-998. Shadmehr, R. & Mussa-Ivaldi, F. (1994). *J Neurosci*, 14 (5), 3208-3224. Shadmehr et al. (2010). *Annu. Rev. Neurosci.*, 33, 89-108. Shmuelof, L. et al. (2012). *J Neurophysiol*, 108, 578-594. Stockinger et al. (2013). *Front. Hum. Neurosci.* 8:231. <http://dx.doi.org/10.3389/fnhum.2014.00231> Wang, J. & Sainburg, R.L. (2004). *J Neurophysiol*, 92, 349-360.

**LATERALITY IN DAILY LIFE, SPORT AND LOCOMOTION ACTIVITIES**

Schwameder, H., Strutzenberger, G., Alexander, N.

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Motor laterality is defined as a morphological and/or functional preference of one side in motor tasks. The arrangement of the extremities in pairs leads to several and substantial advantages of the human species. This is even more distinct in the morphological characteristics and functional preference of one limb in ability, strength and motor tasks. The laterality expressing this preference is quite differently pronounced between humans and might even differ between motor tasks within one individual. It is well known that in daily life and sport activities individuals show a characteristic of laterality or symmetry. Laterality also has an important function regarding performance, comfort, injury prevention, rehabilitation and equipment design in elite and leisure sport. Specific attention should be paid to the effect of unilateral vs. bilateral motor skills of particular sports on the amount of lateral characteristics and their relation to performance and injury prevention in daily living and sport activities (Loffing, 2014; Stöckel & Vater, 2014; Zago et al., 2014; Furlong & Harrison, 2015; Loffing & Hagemann, 2015). Another important issue is the change of laterality due to accidents with severe morphological or functional effects on single limbs (e.g. fracture, tears of ligaments, muscles or tendons, amputation) or strokes (Gosser & Rice, 2015). One of the key questions in this regard is the detection of the border line from there on the amount of laterality is assessed to be excessive and might cause more or less severe health problems in terms of pain, overloading or unilateral abrasion. Examples will be presented regarding the amount of laterality in daily living activities (level and inclined walking, stair climbing, cycling) and sport activities (running, cycling, jumping, leg extension strength) including the discussion of specific aspects, training issues as well as advantages and disadvantages of laterality with respect to performance, comfort and injury prevention. This will be completed by covering aspects of laterality in amputees and unilaterally injured individuals on the feasibility of locomotion, performance and rehabilitation issues. Another aspect will cover the lateral design and lateral tuning of sport equipment focusing on the adjustment of laterality regarding performance enhancement and injury reduction. References Furlong, L. & Harrison, A. (2015). *Laterality*, 20(2): 128-140. Gosser, S. & Rice, M. (2015). *Top Stroke Reh*, 22(1): 56-62. Loffing, F. (2014). *PLoS One*, 9(8). Loffing, F. & Hagemann, N. (2015). *Laterality*, 20(3): 270-286. Stöckel, T. & Vater, C. (2014). *Hum Mov Sci*, 38: 143-151. Zago, M. et al. (2014). *J Hum Kinetic*, 42: 51-61.

**FUNDAMENTALS OF LATERALITY**

Bryden, P.

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Laterality is generally defined as the preference most humans show for one side of the body over the other. It is expressed as lateral preference to the left or right side and specialization of certain functions, such as language and spatial skills, to the left or right hemisphere of the brain. More specifically, handedness can be defined as the hand one prefers or selects to perform unimanual tasks (Annett, 1970), where individuals usually perform tasks faster and more accurately with this hand (e.g., Roy, Bryden & Cavill, 2003). In a similar fashion, footedness can be defined as the lower limb that an individual prefers to perform various tasks, including balancing, stepping, and kicking, where the selected foot is generally more adept (Peters, 1988). One aspect of lateral preference that has garnered significant attention is the finding that certain tasks provoke stronger preferences than other tasks and that such variability is noted across the lifespan (Scharoun & Bryden, 2014;). Individuals have strong preferences for the hand they use to write, but show weaker preferences for tasks requiring less skill (Steenhuis & Bryden, 1999). Parallel findings have been reported for lower limb preference, where individuals tend to show stronger preferences for mobilizing tasks such as kicking, but weaker preference for which foot is used stabilization tasks (Teixeira & Teixeira, 2008), with the magnitude, or even the existence, of the difference in performance abilities between the feet varying depending on the task (Huurnink et al., 2013). Notably, both the strength of lateral preference and the relative magnitude of performance abilities also vary across the lifespan (Musalek, 2015), for both hands (Gooderham & Bryden, 2013) and feet (Riskowski et al., 2012). The focus of this talk will be to review the methods of measurement of lateral preference and performance, describe the basic findings of laterality across the lifespan with respect to skilled movement, and discuss the possible explanations for why individuals prefer one limb over the other, and why performance differences also depend on task and age. References 1. Annett, M., (1970). *British Journal of Psychology*, 61(3), 303-321. 2. Bryden, P. J., et al., (2007). *Laterality*, 12(4), 364-377. 3. Gooderham, S. E. & Bryden, P. J. (2013). *Developmental Psychobiology*, 56(3), 537-546. 4. Musalek, M. (2015). *Frontiers in Psychology*, DOI:10.3389/fpsyg.2014.01513 5. Peters, M. (1988). *Psychological Bulletin*, 103(2), 179-192. 6. Riskowski, J. L., Hagegorn, T. J., Dufour, A. B., & Hannan, M. T. (2012). *J. of Biomechanics*, 45(10), 1796-1802. 7. Roy, E. A., Bryden, P. J., & Cavil, S. (2003). *Brain & Cognition*, 53, 315-317. 8. Steenhuis, R. & Bryden, M. P. (1999). *Laterality*, 3-26 9. Scharoun, S. M., & Bryden, P. J., (2014). *Frontiers in Psychology*, 5, 82. 10. Teixeira, A. & Teixeira, L. (2008). *Laterality*, 141-153. 11. Huurnink, A, et al., (2013). *J. of Biomechanics*, DOI: 10.1016/j.jbiomech.2013.10.002

**Invited symposia**

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**IS-BN09 RATE OF FORCE DEVELOPMENT: NEW IDEAS ON MEASUREMENT, MECHANISMS AND TRAINABILITY**

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**EXPLOSIVE MUSCLE STRENGTH: MEASUREMENT AND FUNCTIONAL RELEVANCE**

Folland, J.

*Loughborough University*

The ability to rapidly develop muscular force ("explosive muscle strength") is considered important in a range of functional situations where the time available to develop force is limited. This includes explosive athletic events (e.g. sprinting, punching) and stabilisation of the musculoskeletal system following a mechanical perturbation that could cause injury (e.g. landing, impact or slip). In addition to this logical rationale there is evidence that explosive strength correlates with, and discriminates for, athletic performance and musculoskeletal stabilisation. However, a direct link between explosive strength and the risk of specific sports injuries (e.g. ACL rupture, hamstrings strain) has not been investigated in prospective epidemiological trials. The purpose of the explosive strength measurement (i.e. to track training and performance or assess underlying physiology) influences the choice of task (e.g. single v multiple joint, and muscle group) and the dynamometer utilised. Explosive muscle strength has typically been measured isometrically. Minimising compliance and max-

imising sensitivity, including use of a high sampling rate, are significant considerations. Data collection using specific explosive contractions with a singular purpose, instructions that emphasise 'fast' or 'explosive' contraction, quantitative feedback on explosive performance and multiple attempts to maximise reliability are recommended. Explosive strength has been quantified with a variety of indices that can be expressed in absolute or relative (to maximum strength or body mass) terms. These include the force (or torque) produced at specific time points from contraction onset; the time to specific forces; the rate of force development (RFD; either maximum, from onset, or over sequential periods); or the impulse/integral (area under) the force-time recording. The choice of the measured variable and its expression should be informed by the purpose of the measurement. Many of these indices are sensitive to the precise definition of contraction onset as well as the initial contractile conditions (rest, pre-tension, countermovement). Given a sufficiently sensitive dynamometer a systematic method of manual onset detection may offer better validity and sensitivity, although being less time efficient for the investigator. The reliability of explosive strength measurements may be contraction phase dependent with lower reliability during the early phase of contraction. Dynamic explosive strength may have more functional relevance to dynamic actions, but is methodologically challenging in order to achieve consistent joint angle and angular velocity conditions that if uncontrolled confound the measurement of explosive strength. Using iso-accelerations to produce standardised mechanical conditions we recently found the ability to express the available torque generating capacity to be greater in concentric than isometric or eccentric explosive actions.

### **NEUROMUSCULAR FACTORS INFLUENCING RATE OF FORCE DEVELOPMENT**

Blazevich, A.J.

*Edith Cowan University*

Muscular force production is the mechanical output resulting from a complex series of physiological events, originating in the central nervous system and ending at the skeleton. However, this process is non-linear, with numerous feedback loops and influences from both internal and external stimuli complicating its progression. Understanding the factors influencing this process is important if we are to develop strategies to improve the rate at which this force is produced, which is a primary goal in many clinical and exercise/sporting contexts. It is well documented that training-induced increases in central (neural) drive, leading to a faster activation of the motor unit pool, and at higher motor unit discharge rates (particularly at the onset of contraction), result in higher rates of force development (RFDs). However, on-going research is attempting to demonstrate how alterations in monoaminergic drive from supraspinal centres such as locus coeruleus and raphe nuclei might influence this drive, and consequently influence RFD. Also changes in afferent feedback, particularly from muscle spindles (stretch-sensitive receptors) via the Ia feedback loop, should theoretically influence motor neurone excitability and thus the ability to drive them maximally. Therefore, the combination of Ia activity and significant monoaminergic drive might provide perfect conditions for fast rates of muscle activation to be achieved through voluntary (i.e. supraspinal/cortical) drive. In this presentation, an overview of these hypotheses and preliminary data showing the potential importance of these factors will be presented. Even after fast rates of activation are achieved, muscular forces must be developed and these forces must be rapidly transmitted through the tendon(s) to the bone(s). At the muscular level, it is well known that the proportion of fast myosin within, and overall size (and therefore strength) of, muscles influences RFD. However, factors such as intra-muscular osmotic pressure, muscle architecture and inter-fascicular and inter-muscular force transmission efficiency are potentially key players. At present little is known about the relative influence of these factors, partly because they are difficult to study. Some consideration will therefore be given to future lines of research that might elucidate the importance of these factors. Additionally, tendon stiffness may also play a role in mediating the rate of force rise, as tendons provide the conduit through which the muscular forces are transmitted to the bone. Substantial evidence in favour of the importance of tendon stiffness for fast RFDs has been published. However, other lines of evidence suggest that force transmission through the tendon is too rapid (a few milliseconds) and changes in this transmission time so small that its influence on RFD is unlikely to be practically meaningful. This conflict of evidence will be considered in the current presentation.

### **RATE OF FORCE DEVELOPMENT: ITS RESPONSE TO ACUTE EXERCISE AND CHRONIC PHYSICAL TRAINING**

Maffiuletti, N.A.

*Schulthess Clinic*

A burgeoning of research has led to an increase in the quantity of data influencing our understanding of the effect of acute and chronic exercise on RFD. Such data has indicated that chronic strength and plyometric-type training can elicit significant increases in RFD, however they also indicate that heavier (and thus slower) forms of training elicit the greatest improvements in RFD; such data are not consistent with current hypotheses of how RFD should be best trained (i.e. using faster movement speeds). However, the results of recent research examining the impact of both acute exercise and chronic strength training, stretching and other interventions, as well as a reflection on the neuromuscular factors that influence force development, has helped us to better explain these findings. It has also led to the development of testable hypotheses as to new ways of improving RFD in a range of populations (e.g. clinical, elderly, child, injured). In this presentation, an overview of the results of studies examining the influence of exercise and chronic physical training (including strength, speed, plyometrics, muscle stretching, etc.) on RFD will be presented. Subsequently, an in-depth analysis of the effects of training on the key factors influencing RFD will be described, which should provide the basis of hypotheses for further research in the area; an important aim is to develop new ideas as to methods of RFD enhancement in a variety of subject populations.

## **Invited symposia**

### **IS-SH06 SPORT AND PHYSICAL ACTIVITY IN LATER LIFE**

#### **FROM SEDENTARY SENIORS TO ELITE ATHLETES – CHANGING PRACTICES AND IMAGES OF OLDER ADULTS**

Pfister, G.

*University of Copenhagen*

Since several decades, statistical information about the physical activity patterns of different age groups is available in Europe. The accessible data clearly reveal a large increase of sport participants among the older populations. In some countries, e.g. in Denmark, the percentage of physical active women over 70 is as high as among much younger age cohorts. In addition, the participation of seniors in

sport competitions has increased, as demonstrated by the popularity of the “master games movement” and the upswing of sport events for older participants. The participation and the performances of older athletes are covered positively in the mass media. However, we do not know if this new interest in the master sport movement has an effect on ageism, stereotypes about the abilities of older people. In this presentation, I will provide a short overview about the history of ageing and the opportunities and challenges of seniors to participate in sport. Based on the results of a media analysis, I will show how the media coverage of senior sport participants has changed and which new images and messages are conveyed. The findings are interpreted on the backdrop of current trends in Western societies, in particular of the new enhancement discourses and the marketing of health, youth and beauty. The paper ends with a discussion about the benefits and problems connected with the new life styles of older adults.

### **SPORT AND PHYSICAL ACTIVITY IN LATER LIFE - METHODOLOGICAL AND GERAGOGICAL ISSUES**

Diketmüller, R.

*University of Vienna*

In recent years a large number of programs promoting physical activity for older people has been developed. Nevertheless, sedentary older and very old people are hardly to be reached. To achieve the personal needs and interests of this group a more enriched body of knowledge (Grant & Kluge, 2007) is necessary to focus not only on lived experiences of physically active elderly, but especially on those who are inactive for different reasons. To know more about their meanings of (not) being active in old age, seems to be crucial for research and promotional approaches as well. On the other hand, being categorized and defined as ‘old’ seems to be already a barrier itself for a number of elderly people who don’t identify with ‘that’ age group and are not interested in age-specific offers. Sport and physical activity in old age as a challenge for staying healthy, young and independent can also be seen a meaning of struggle against the ageing process. Addressing the critique that studies of exercise and aging have been dominated by positivist approaches (Markula et al. 2001), this paper examines methodological and ethical issues in the research with elderly people and its significance for data collection. Based on the results of different studies (interview, focus group discussion) with elderly active and inactive men and women geragogical approaches for (health) promoting programs are discussed (Kolb & Diketmueller, 2006; 2008).

### **PARTICIPATION IN PHYSICAL ACTIVITY AND SPORT AMONG OLDER NORWEGIANS: A LONGITUDINAL STUDY FROM 1985 TO 2013.**

Fasting, K.

*Norwegian School of Sport Sciences*

Research from most countries, indicates that physical activity participation levels decrease with age, and that men are considerably more likely to take part in sports than women. But in Norway, particularly when sport and physical activities are broadly defined, women seem to be as active as men. The question is if this also holds for elderly people? The purpose is therefore to find out more about the development in the participation rate, performance level and the types of physical activity and sport among Norwegian women and men older than 65 year of age. The data analysed is from the study “Norwegian Monitor on Social and Cultural Change”, which has been carried out by Ipsos MMI every second year since 1985, and covers representative samples of the Norwegian population 15 years and above. For this paper the age group 65 and higher has been analysed. The physical activity level was measured through the following question: “How often would you say that you participate in physical activity either as training or as exercise?” In measuring the type of activity the participants were confronted with a list of activities and asked to answer the following question: “Which of these different physical activities on the list below do you participate in at least once a month during the season in your leisure time? » The results show that elderly women in 2013 are as active as men, respectively 80 and 79 %, defined as exercise more than once per week. The equivalent numbers from 1985 were 45 and 59 %. Accordingly the gender gap has disappeared. This seems to hold independently of how often women and men exercise. The largest increase in activity level was found among women who exercised 3-4 times per week, from 7% in 1985 to 31% in 2013. But when we look at participation in competitions a gender difference in favor of men emerge. In 2013 only 6% of the women compared to 12% of the men had participated in competitive sport. The most popular activity for both women and men are walking in the woods, followed by cross-country skiing in the woods and hiking in the mountains. The last ten years women who walk in the woods have increased from 46 to 69 %. Another major increase in women’s physical activity since 1985 has taken place in gymnastics/jazz/aerobics/freestyle (+ 13%), followed by swimming and dance (+ 8% in both), activities that also in 2013 many more women are participating in than men. These results will be discussed in relation to social constructivist theory which looks upon gender, ageing and sport preferences as socially constructed. In the discussion the question is raised whether elderly women experience a glass ceiling in relation to participation in competitive sport, and if these results may be a production of the gender stereotypes in society at large.

## **Invited symposia**

### **IS-SH05 GOOD GOVERNANCE IN SPORTS**

#### **ACTION FOR GOOD GOVERNANCE IN INTERNATIONAL SPORTS ORGANISATIONS**

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The paper is based, in part, on research led by the Play the Game organisation and reports the work of the Action for Good Governance in International Sport Organisation (AGGIS) research consortium. The aim of the paper is twofold: first, to present the framework developed by the Play the Game research consortium which was designed to provide an assessment of the quality of governance in international sport organisations; and second, to evaluate the implementation and potential impact of the framework within the contemporary political and business environment. The paper begins with a discussion of the four main elements of ‘good governance’ (transparency, democracy, checks and balances and solidarity) before moving on to analyse the challenges of achieving compliance with higher standards of governance and holding international sport organisations to account. A variety of conceptualisations of accountability are examined including hierarchical, market-based and horizontal. The paper then considers the roles and responsibilities of stakeholders in relation to the achievement of higher standards of governance. The main conclusions drawn from the analysis are: a) few international

sport organisations recognise good governance as beneficial to their business; b) horizontal accountability through stakeholder action is weak; c) upward accountability does not exist; and d) downward accountability to the market might be the only effective way of trying to raise standards of governance.

## TRANSPARENCY AND ACCOUNTABILITY IN INTERNATIONAL SPORT ORGANIZATIONS

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When I became a member of the Management Committee of the International Cycling Union (UCI) in summer 2000 I was just naïve: Proud to be the first woman ever in such a position of the cycling world, optimistic with regard to what this step would mean: Change is possible. I soon learned otherwise. While the President of UCI, Hein Verbruggen, was happy to present a woman, thus showing his federation's good will with regard to gender equality, and welcomed any critical question I raised, he as well told me: "Whatever you may want to discuss, Sylvia, in the end I expect you to vote with yes. I will never accept a dissenting vote." And so he did – he stopped any voting in our board as soon as he feared me not consenting with him. Five years experience in UCI told me all one needs to know about (non-)transparency and (non-)accountability in international sport organizations. But how can one use this knowledge in practice, how can real change in sport be achieved? To develop a strategy for Good Governance, i.e. transparency and accountability in sport the power of sport organizations as well as their monopoly position, the mechanisms of their structure, and their specific membership should be taken into account. Measuring administrative key performance indicators without looking onto the power play behind the scenes can lead to results that hide more than they disclose. The interdependence of sport, business, politics and media with manifold conflicts of interests on all sides is one of the biggest obstacles to integrity in sport. This is exemplified by the ongoing discussion on FIFA as well as in other sport organizations. With its Agenda 2020 process the International Olympic Committee has taken a first step to reform itself and promote transparency and accountability. But the work has just begun. Do not insert authors here

## GOOD GOVERNANCE FROM A NATIONAL PERSPECTIVE: THE CASE OF SWEDEN

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In recent years, good governance has been established as an overarching concept for the struggle against corruption and abuse of power in both international sports organizations and the hosting of major championships. Still, in Sweden, the concept is to a large extent unknown. This can partly be explained by the fact that Swedish sport is weakly represented in international sports organizations, and rarely hosts major sporting events. Further, a strong popular movement tradition and limited commercialization have fostered a notion that Swedish sport has been spared from such economic and democratic problems. However, a new study regarding economy and ethics in local sport clubs indicates the occurrence of financial irregularities and the need for increased awareness of the principles of good governance. Method The study was conducted by The Swedish National Centre for Research in Sports (CIF) and United Minds as part of CIF's assignment to monitor government support to sport. A web-based questionnaire concerning financial management and ethics was sent to the treasurers of all local sports clubs within The Swedish Confederation of Sports. 5480 treasurers responded, representing a response rate of 34 percent. A non-response analysis showed that the questionnaire replies were evenly distributed across the country and that all sports were represented. Results The treasurer's description of Swedish sports confirms the picture of a non-profit movement with low degree of professionalization and commercialisation. A majority of the sports clubs are small (fewer than 200 members) and primarily engaged in youth sports. Their turnover is low and member fees are their main source of revenue. Only three out of ten clubs have employees and a majority of the cashiers lack professional experience in the areas of finance and accounting. According to the cashiers, economic irregularities are common among Swedish sports clubs. Most common are unaware irregularities, caused by carelessness, ignorance or stress. But one out of four also state that it is common with conscious financial fouls with the aim to support the clubs non-profit endeavours. Discussion The study indicates a perception in Swedish club sports that financial irregularities can be justified if they serve a good purpose. Increased awareness of Good governance can be an important strategy to counteract such views. References Centrum för idrottsforskning 2014:3 Etik och ekonomi i idrottsföreningar

## Oral presentations

### OP-PM20 Physiology: Muscle metabolism, Interval training

#### MITOCHONDRIAL FUNCTION AND CONTENT ARE INCREASED BY DIFFERENT TYPES OF TRAINING IN HUMAN SKELETAL MUSCLE.

Bishop, D.J., Granata, C., Oliveira, R.S.F., Little, J.P., Renner, K.

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Introduction Mitochondria are key components of skeletal muscles, as they provide the energy required for almost all cellular activities and play an important role in ageing and cell pathology. Exercise is one factor that has been shown to provide a powerful stimulus to increase both mitochondrial content and/or respiratory function, yet little is known about the optimal exercise dose, and whether mitochondrial content and respiratory function are altered by the same or different exercise prescriptions. It has been hypothesised that changes in mitochondrial content seem to depend on training volume, whilst changes in mitochondrial respiratory function seem to be related to training intensity (Bishop et al., 2014). The aim of the present study was to investigate this hypothesis. Methods Twenty-nine healthy men ( $21 \pm 2$  y,  $46 \pm 6$  mL O<sub>2</sub>/min/kg) took part in 12 cycling sessions (4 weeks) of either: sprint interval training (SIT, 4-10 X 30-s "all-out" bouts (~204% WPeak); n=9), high-intensity interval training (HIT, 4-7 X 4-min intervals at ~89% WPeak; n=11), or sub-lactate threshold continuous training (STCT, 20-36 min at 90-97.5% WLT (~69% WPeak); n=9). The STCT and HIT group were also matched for total work. Following the 4 wk of training, the HIT group then continued HIT twice a day for 20 consecutive days (High Volume Training; HVT). Resting muscle biopsy samples were obtained before and after training for all groups. Results Maximal mitochondrial respiration in permeabilised muscle fibres increased significantly only following SIT ( $25 \pm 20\%$ ,  $P < 0.05$ ). However, citrate synthase activity, and the protein content of PGC-1 $\alpha$  and subunits of ETS complexes, only increased following HVT (all  $P < 0.05$ ). The protein content of PGC-1 $\alpha$ , p53 and PHF20

was increased following both SIT and HVT ( $P < 0.05$ ). Discussion Our findings suggest that training intensity is a key factor regulating exercise-induced changes in mitochondrial respiration, whereas training volume is more important for exercise-induced changes in mitochondrial content. Furthermore, there exists an apparent dissociation between training-induced changes in mitochondrial respiration and content. While further research is required, it is possible that the increase in mitochondrial respiratory function, without a change in mitochondrial content, may be the result of matched changes in protein synthesis and degradation resulting in the replacement of damaged proteins with newly synthesised ones (Mai et al., 2012). References Bishop DJ, Granata C & Eynon N. (2014). *Biochimica Et Biophysica Acta* 1840, 1266-1275. Mai S, Muster B, Bereiter-Hahn J & Jendrach M. (2012). *Autophagy* 8, 47-62. Contact: David.Bishop@vu.edu.au

### EFFECT OF HIGH INTENSITY TRAINING ON INSULIN SENSITIVITY IN OVERWEIGHT, SEDENTARY ELDERLY SUBJECTS

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Søgaard, D., Lund, MT., Dehlbæk, MS., Dideriksen, SG., Abildskov, CV., Dela, F., Helge, JW. Xlab, Dept. Biomedical Sciences, University of Copenhagen, Denmark Introduction High intensity training (HIT) induces beneficial changes on insulin sensitivity evaluated by the Matsuda index in young adults (Whyte LJ et al. 2010), but it is not clear if HIT can be applied to elderly subjects with positive effects on metabolism. This study aims to investigate the effect of 6 weeks of HIT on insulin mediated glucose uptake rates in elderly, overweight and sedentary subjects. We hypothesized that HIT would improve insulin whole body insulin action in both male and female elderly subjects. Methods Thirteen (6 M/7 F,  $62 \pm 1$  yrs., BMI  $> 27$  kg/m<sup>2</sup>) subjects performed supervised HIT training 3 sessions a week in 6 weeks in this ongoing study. Each session consisted of 5 intervals of 60 sec. of HIT on a bicycle ergometer with 90 sec. break after each interval. A hyperinsulinemic, euglycemic clamp and a VO<sub>2</sub>max test were carried out before and after the intervention. Statistics: Two way repeated measurements ANOVA was applied to the data. Results Six weeks of HIT induced a significant increase in VO<sub>2</sub>max (ml • min<sup>-1</sup> • kg<sup>-1</sup>) (pre:  $25.9 \pm 1.3$ , post:  $28.0 \pm 1.5$ ,  $p=0.032$ ,  $n=13$ ). Glucose infusion rates (GIR, mg • min<sup>-1</sup> • kg<sup>-1</sup>) overall increased (pre:  $7.4 \pm 0.4$ , post:  $8.0 \pm 0.6$ ,  $p=0.008$ ,  $n=13$ ), which was caused by an improved GIR in males (pre:  $7.7 \pm 0.5$ , post:  $8.7 \pm 0.7$   $p=0.002$ ,  $n=6$ ) but not females (pre:  $7.2 \pm 0.7$ , post:  $7.3 \pm 0.9$ ,  $p=0.676$ ,  $n=7$ ). Glucose clearance rate (ml • min<sup>-1</sup> • kg<sup>-1</sup>) was increased overall (pre:  $7.3 \pm 0.4$ , post:  $8.1 \pm 0.6$ ,  $p=0.032$ ,  $n=13$ ). Discussion HIT is feasible in elderly subjects and improve VO<sub>2</sub>max and insulin action. Insulin mediated glucose uptake in elderly subjects completing a HIT intervention has not previously been measured. The findings of our study do agree with a study reporting an increase in insulin sensitivity in young sedentary males in response to HIT (Richards JC et al. 2010). We only see an improvement in males and not females and therefore our present results only partly support our hypothesis. In conclusion, HIT can be applied to elderly but males may benefit more than females. Gender specific differences in the adaptation to HIT training should be studied further to elucidate a possible mechanism. References Whyte LJ, Gill JMR, Cathcart JA. (2010) *Metabolism Clinical and Experimental*, 59, 1421-1428. Richards JC, Johnson TK, Kuzma JN, Lonac MC, Schweder MM, Voyles WF, Bell C. (2010). *J Physiol*, 588.15, 2961-2972. Contact dittek@sund.ku.dk

### BROWN ADIPOSE TISSUE GLUCOSE UPTAKE IS DECREASED BY TWO WEEKS OF EXERCISE TRAINING IN HEALTHY MIDDLE AGED MEN

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Objective: We have previously shown that brown adipose tissue (BAT) glucose uptake is stimulated by insulin. The aim of this study was to evaluate whether exercise improves BAT insulin sensitivity as it does in skeletal muscle. Materials and methods: Healthy middle-aged men ( $n=18$ , aged= $47.2$ (SD 4.6) yrs, BMI= $25.3$ (SD 2.4) kg·m<sup>-2</sup>, VO<sub>2</sub>max= $34.8$ (SD 4.5) ml·kg<sup>-1</sup>·min<sup>-1</sup>) were recruited. Glucose uptake (GU) in BAT and quadriceps femoris muscles were measured during euglycemic hyperinsulinemic clamp before and after two weeks of bicycle exercise training intervention using positron emission tomography and [<sup>18</sup>F]FDG. From these, individuals were divided into two groups BAT positive ( $n=6$ ) with high BAT GU ( $\geq 2.9$  μmol/100g/min) and BAT negative group ( $n=12$ ) with BAT GU ( $\leq 2.9$  μmol/100g/min) at baseline. Plasma irisin levels were measured before and after the intervention. Results: After intervention VO<sub>2</sub>max (pre  $34.8$ (SE 1.2) vs. post  $37.0$ (SE 1.2),  $p=0.0005$ ) and quadriceps femoris muscle GU (pre  $8.2$ (SE 1.2) vs. post  $11.9$ (SE 1.2),  $p=0.001$ ) improved in both groups with no significant differences between the groups. Training decreased BAT GU in BAT positive group whereas opposite was observed in BAT negative group ( $4.0$ (SE 1.2) vs.  $2.6$ (SE 1.2) and  $1.5$ (SE 1.1) vs.  $1.6$ (SE 1.1),  $p=0.02$ , respectively). Irisin levels did not change. Conclusion: The effects of short term bicycle exercise training are different on skeletal muscle and BAT insulin sensitivity. Against our hypothesis, insulin stimulated BAT GU decreased in BAT positive subjects, suggesting that short term exercise training is not effective strategy to enhance BAT metabolism. Do not insert authors here

### THE ASSOCIATION OF SNAP23 WITH THE MITOCHONDRIAL NETWORK IS REDUCED IN SKELETAL MUSCLE OF OBESE SEDENTARY FEMALES

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Introduction SNAP23 is a SNARE protein involved in GLUT4 docking at the skeletal muscle plasma membrane. However, it has also been proposed that, under high lipid flux (e.g. obesity), SNAP23 can be sequestered away from the plasma membrane for fusion of growing lipid droplets (LD). It is thought that this results in decreased plasma membrane SNAP23 content limiting the capacity for GLUT4 docking and therefore glucose entry into the cell. This is known as the hijacking hypothesis (Sollner, 2007). The present study aimed to investigate the distribution of SNAP23 in skeletal muscle of non-obese and obese older women using immunofluorescence microscopy. We aimed to generate evidence for the hijacking hypothesis and also to investigate the potential role of SNAP23 in mitochondrial fatty acid (FA) oxidation. Methods Participants were six non-obese ( $m \pm SD$ , age:  $62 \pm 3$  years, BMI:  $22.6 \pm 1.4$ , HOMA-IR  $3.9 \pm 1.2$ ) and six obese older women (age:  $68 \pm 3$  years, BMI:  $33.3 \pm 1.6$ , HOMA-IR:  $6.2 \pm 1.3$ ) undergoing elective orthopaedic surgery. Biopsies were obtained from the m. gluteus maximus during hip arthroplasty. Cryosections ( $5 \mu m$ ) were labelled with antibodies targeting SNAP23, mitochondria (anti-cytochrome c oxidase) and the plasma membrane (anti-dystrophin). LD were visualised using oil red O. Results SNAP23 partially colocalised with the plasma membrane in both non-obese and obese individuals (Pearson's correlation non-obese:  $r = 0.39 \pm 0.01$ , obese:  $r = 0.37 \pm 0.03$ ,  $P=0.64$ ). SNAP23 also partially colocalised with mitochondria with significantly more colocalisation in non-obese women than obese women (non-obese:  $r = 0.34 \pm 0.03$ , obese:  $r = 0.27 \pm 0.03$ ,  $P=0.04$ ). SNAP23 weakly colocalised with LD in both non-obese and

obese individuals (non-obese:  $r = 0.12 \pm 0.02$ , obese:  $r = 0.07 \pm 0.02$ ,  $P = 0.28$ ). Discussion This study did not confirm the hypothesis that LD hijack SNAP23 from the plasma membrane. The association of SNAP23 with LD was low and the association of SNAP23 with the plasma membrane was not reduced by obesity. SNAP23's presence at the mitochondria supports its proposed role to channel FA released from LD hydrolysis into the mitochondria for oxidation. The reduced association between SNAP23 and the mitochondria in obesity may suggest a decreased capacity for FA oxidation in these individuals which would be expected to lead to greater insulin resistance in skeletal muscle.

### **ANABOLIC STEROID DETECTION BY PROTEOMICS IN HUMAN SKELETAL MUSCLE**

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This project proposes to use a sensitive proteomic methodology to detect deviations in human skeletal muscle protein profiles between muscles of doped and clean athletes. Testosterone increases muscle mass as well as muscle fibre area in a dose dependent response. We have shown a higher number of nuclei per muscle fibre is observed in doped, compared to clean athletes that may give permanent, life-long performance advantages even when AAS intake has been withdrawn for many years. Detection of AAS in human urine and blood may not at all be sufficient to reveal the use of banned substances, and the benefits of their actions. The LC/MS/MS method is used for doping analysis of biological samples such as urine, blood, plasma, serum, hair and saliva. We will extend the use to human skeletal muscle, where doping can be detected many years after secession of intake, and not limited to short-lived metabolites of banned substances detectable in urine and blood. The amount of tissue needed for the analysis is  $< 2$  mg, and the sampling procedure equivalent to a regular venous blood sampling, resulting in  $> 6000$  identified and quantified peptides. Detection and quantification of permanent effects of AAS abuse when metabolites have been excreted, and for years after secession of AAS intake, requires analysis of muscle tissue. The small amount of tissue needed allows the use of fine needle biopsies that are safe, minimally invasive and cause limited or no pain and discomfort. The present study will therefore be the first to develop a valid and reliable test for the detection of long-term effects of AAS abuse on muscle tissue. In addition, the proposed approach may be the only possibility to detect future, or on-going, genetic doping.

### **EXERCISE TRAINING ACTIVATES NRG1/ERBB PATHWAY IN GASTROCNEMIUS OF OBESE RATS**

Chavanelle, V., Ennequin, G., Caillaud, K., Gerbaix, M., Metz, L., Etienne, M., Walrand, S., Masgrau, A., Guillet, C., Courteix, D., Niu, A., Li, Y., Capel, F., Boisseau, N., Sirvent, P.

*AME2P - EA 3533*

Introduction Some studies suggest that the signaling pathway of neuregulin 1 (NRG1), a protein involved in skeletal muscle metabolism regulation, could be altered by nutritional and exercise interventions (Miller T et al., 2009; Lebrasseur et al., 2005). We hypothesized that diet-induced obesity could be associated with alterations of the NRG1 signaling pathway and that chronic endurance exercise could improve NRG1 signaling in rat skeletal muscle. Methods Male Wistar rats were fed a high fat/high sucrose (HF/HS) diet for 16 weeks. At the end of this period, NRG1 and ErbB expression/activity were assessed in skeletal muscle of obese rats suffering from glucose intolerance induced by the HF/HS diet and compared to control rats (non-obese, well-balanced diet). Then, the obese rats continued the HF/HS diet or were switched to a well-balanced diet. In both cases, two subgroups were made: rats were assigned to a sedentary group or a chronic exercise group for another 8 weeks and NRG1 and ErbB expression/activity in skeletal muscle were tested again. Results First, we found that a 16-week HF/HS diet induced obesity, but did not significantly affect the NRG1/ErbB signaling pathway in rat skeletal muscle. Conversely, after the switch to a well-balanced diet, NRG1 cleavage ratio and ErbB4 amount were increased. Chronic exercise training also induced NRG1 cleavage, resulting in increased ErbB4 phosphorylation. This was associated with increased protein expression and phosphorylation ratio of the metalloprotease ADAM17, which is involved in NRG1 shedding. Similarly, in vitro stretch-induced activation of ADAM17 in rat myoblasts induced NRG1 cleavage and ErbB4 activation. Discussion These results showed that endurance training and well-balanced diet activates the NRG1-ErbB4 pathway in skeletal muscle of diet-induced obese rats. This effect seems mediated by the cleavage of NRG1 by the metalloprotease ADAM17.

## **Oral presentations**

### **OP-BN02 Motor learning**

#### **MOTOR IMAGERY OF TONIC AND BALLISTIC CONTRACTIONS ACTIVATES DIRECT AND INDIRECT CORTICOSPINAL PATHWAYS DIFFERENTLY BUT IN A SIMILAR WAY THAN REAL TONIC AND BALLISTIC CONTRACTIONS**

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Introduction It is well accepted that motor imagery (MI) and actual movements share overlapping activation of motor areas (Jeannerod 2001). One possibility to assess neural activation during MI is to apply transcranial magnetic stimulation (TMS) over the primary motor cortex. This technique showed that MI and actual movements modulate motor cortex excitability similarly (Stinear CM, Byblow WD 2003). It is, however, not known if MI also affects the activity of different corticospinal pathways in a contraction-specific way as was shown for actually executed movements (Taube et al. 2011). The aim of the present study was therefore to elucidate whether MI of tonic and ballistic contractions leads to differential activity of direct and indirect corticospinal pathways. Methods Ten healthy participants volunteered for the present study. Activity of the different corticospinal pathways was assessed at rest and during MI of ballistic (MIbal) and tonic (MIton) contractions using the H-reflex conditioning technique. Therefore, the soleus H-reflex was conditioned with TMS using different interstimulus intervals. In order to avoid biased MEP / H-reflex amplitudes due to voluntary or involuntary contractions, trials with enhanced EMG levels prior to stimulation (time window: 5 to 55 ms before stimulation; criteria:  $> 4$  times standard deviation) were removed. Results The conditioned H-reflexes of the early facilitation, which indicate the contribution of direct corticospinal pathways, were not different between rest, MIbal and MIton ( $F_{2,18} = 0.67$ ;  $p = 0.52$ ). The conditioned H-reflexes that reflect activity of indirect, slower corticospinal pathways were significantly different ( $F_{2,18} = 4.25$ ;  $p < 0.05$ ) between conditions, revealing highest facilitation in MIton, followed by rest and MIbal. Discus-

sion Previous studies have shown that slow corticospinal pathways are differently affected by ballistic and tonic contractions (Taube et al. 2011, Nielsen & Petersen 1995, Nielsen et al. 1993). The authors showed for physical task execution a late inhibition for ballistic contractions but a late facilitation during tonic contractions. Thus, the present study shows for the first time that MI of ballistic and tonic contractions activates corticospinal pathways in a contraction-specific way that resembles activation patterns during physical task execution. References Jeannerod (2001). *NeuroImage*, 14:103-109. Nielsen J, Petersen N (1995). *J Physiol*, 484:777-789. Nielsen J, Petersen N, Deuschl G, Ballegaard M (1993). *J Physiol*, 471:223-243. Stinear CM, Byblow WD (2003). *Clin Neurophysiol*, 114(5):909-14. Taube W, Lundbye-Jensen J, Schubert M, Gollhofer A, Leukel C (2011). *PLoS One*, 6(10):e25657. Contact martin.keller@unifr.ch

### IN SITU EXAMINATION OF DECISION MAKING SKILLS AND GAZE BEHAVIOUR OF BASKETBALL PLAYERS

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*VU University*

**Introduction** Several studies have revealed that experts possess superior decision making skills, i.e., they make more accurate and faster decisions than non-experts (e.g., Vaeyens et al., 2007). However, using video projection and artificial responses most of these studies lacked representative design and natural perception-action couplings (Travassos et al., 2013). The aim of the current study was to examine expertise effects in decision making and gaze behaviour in situ. **Methods** Highly talented youth basketball players participated as ball carrier in a specific 3 vs 3 pick-and-roll basketball play. Facing three types of defensive play, the ball carrier chose and performed one of four options: shoot, drive to the basket, pass to the screener/roller or pass to the corner player. Players wore eye tracking glasses and performed trials on the left and right side of the field. The chosen options, quality of decisions and gaze behaviour were analysed. Successful and less-successful decision makers were compared. Results Different defensive plays led to differences in options chosen. A loglinear analysis indicated that the side x defensive play x option interaction was almost significant,  $\chi^2(8) = 15.130$ ,  $p = .057$ . For one defensive play, the shot was chosen more often on the left side than on the right side while for another defensive play the ball was more often passed to the screener on the left side and to the corner on the right side of the field. Successful players more often chose the best option compared to less-successful players,  $p < .001$ . The final fixation of successful players was more often on the chosen option,  $p < .05$ , and tended to be longer,  $p = .099$ , than of the less-successful players. **Discussion** We showed that it is possible to measure decision making skills and gaze behaviour in situ. The decisions were affected by the defensive play and the side of the field, of which the latter may be due to hand dominance. Within the group of highly talented players, the successful and less-successful decision makers could be differentiated. Further analyses of gaze behaviour may give insight into why some players make better decisions than others. **References** Travassos, B., Araújo, D., Davids, K., O'Hara, K., Leitão, J., & Cortinhas, A. (2013). Expertise effects on decision-making in sport are constrained by requisite response behaviours - A meta-analysis. *Psychology of Sport and Exercise*, 14, 211-219. Vaeyens, R., Lenoir, M., Williams, A. M., & Philippaerts, R. M. (2007). Mechanisms underpinning successful decision making in skilled youth soccer players: an analysis of visual search behaviors. *Journal of Motor Behavior*, 39, 395-408. Contact m.van.maarseveen@vu.nl

### A COMPARISON OF LOWER EXTREMITIES ANATOMICAL AND FUNCTIONAL ASYMMETRIES IN ELITE AND SUB-ELITE FENCERS.

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**Introduction** In order to design effective and appropriate training programs there is a need to examine sport specific skills in all levels of athletes. The aim of this study was to investigate and compare possible lower extremity asymmetries in elite and sub-elite level fencers. **Methods** Anthropometric and functional parameters were tested in 27 (12 female and 15 male) members of the Greek National Fencing team (M age = 19.9 yr., SD = 3.5 yr, M height = 175.6 cm., SD = 7.6 cm., M weight = 66.1 kg., SD = 9.1 kg.) and classified as elite (n=10) or sub-elite (n=17) fencers, according to their international standard. The anthropometric parameters included weight, height, mid- thigh skinfold and thigh circumference. Mid-thigh muscle cross-sectional area (CSA) on the dominant (D) and non dominant (ND) side was calculated from an anthropometric formula incorporating limb circumference and skinfolds. Countermovement jump (CMJ) and hip flexibility (FLEX) were measured on the dominant (D) and non-dominant (ND) side using a Chronojump platform and a Lafayette goniometer. Results Elite fencers were significantly superior to sub-elite fencers in CSA-D (6.9%,  $p < 0.001$ ), FLEX-D (18.9%,  $p < 0.05$ ) and FLEX-ND (18.3%,  $p < 0.05$ ), while there were no significant differences for CMJ performance and the rest of anthropometric parameters. Also, significant differences were observed for elite fencers between the D and ND side for CMJD - CMJND (18.6%,  $p < 0.05$ ) and CSAD-CSAND (8.7%,  $p < 0.001$ ). Smaller significant differences were observed for sub-elite fencers between the D and ND side for CMJD - CMJND (14.7%,  $p < 0.05$ ) and CSAD-CSAND (6%,  $p < 0.001$ ). CMJ asymmetries were not correlated with the relevant asymmetries in CSA in both groups of fencers. **Discussion** Based on the above results, we conclude that both anatomical and functional asymmetries differentiate elite from sub-elite fencers in forward body propulsion. These asymmetries are most likely developed as a consequence of the specificity of the fencing training program. The observations in this study confirm different leg quality requisites all of which seem to be important in functional power characteristics of fencing performance, especially in elite fencers. Also, this observed superiority of elite fencers to sub-elite fencers may be useful for athletes and coaches to design more effective talent development training programs. Contact alceekotsasian@yahoo.com

### SPATIAL ANALYSIS OF HIT DISTRIBUTION IN RECURVE ARCHERY

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**Introduction** An end consists of 3 to 6 arrows, which are typically written on paper without information on the location of each arrow (Ertan et al., 2005). The arrows are only scored from highest to lowest leading to limited analysis possibilities. Distribution patterns of the hits on the target allow identification and analysis of spatial patterns (Callaway & Broomfield, 2012). Callaway and Broomfield (2012) validated an input method for these hits to analyse underlying continuous spatial distributions (Johnson, 2001). The purpose of the current study is to test whether marksmanship characteristics derived from hit distribution patterns can be used to differentiate archers at different performance levels. **Methods** Archers comprised of 3 groups (9 high-level, 13 middle-class and 7 beginner archers). Each archer shot 72 arrows at a 40cm target standing at 18 m. The hits on the target were photographed after each end and digitized using Matlab to create a coordinate system of arrow locations. Accuracy (variable & constant), precision, group locations, and straight-line distance (from the center) were calculated for each group and analysed using ANOVA and post-hoc LSD. Results Accuracy (AVE) showed elite were the



closest to the center with 3.02cm, intermediate = 7.75cm and beginner = 17.1cm. Group X locations showed elite and intermediate to the left of the target (-0.79cm & -4.18cm) and beginners to the right (1.57cm). Beginners showed a closer group to the center of the target than intermediate, but also the largest SD of 8cm. Group Y location showed that Intermediate and Beginner both shot 1.03 and 1.43cm high of the center with no significant difference between them. Elite shot -1.24cm low of center. Precision resulted in elite = 2.42, intermediate = 5.38 & beginner = 12.3cm size groups. Statistical differences were found between all factors, for all groups ( $p < 0.001$ ) except between intermediate and beginner group Y location. Discussion As predicted, there were significant differences between elite, intermediate and beginner hit distribution. This demonstrates that the methods proposed previously (Callaway & Broomfield, 2012) can be useful for analysis in archery. Score alone ignores good groups in the wrong location on the target. Measures such as accuracy and precision offer a great benefit to future work. These measures here can be useful to archer, coach and analyst for performance improvements and equipment setup. If all archers had moved their sights in line with the results here, all could have scored higher overall. References H. Ertan, A.R. Soylu and F. Korkusuz (2005). *J. Elec. & Kin.*, 15, 222–227. A.J. Callaway & S.A. Broomfield. (2012). *Int. J. Perf. Analysis in Sport*, 12(2), 291-310. R.F. Johnson. (2001). *U.S. Army Res. Ins. of Env. Med. Natick. MA 01760-5007*– P. 1-19.

### **'THE LEFT HAND HAS TO GO BACK A BIT MORE, LIKE THIS': INTERACTION ANALYSES OF COMMUNICATIVE STRATEGIES IN DRESSAGE COACHING**

Lundgren, C., Zetterqvist Blokhuis, M.

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In the equestrian sports, the communication between horse and rider is considered paramount to good riding. At the same time, riding is a very complex activity. Because of this, many riders, including those who use their horses exclusively for recreational activities, regularly participate in training sessions led by professional trainers. In the study reported in this paper, video recordings of dressage training sessions have been analysed. Participating in these 15 training sessions are five different trainers, each coaching three equipages (one trainer and one equipage per training session of 45-60 min). Combining theories and methods from linguistics and communication theory, the study sheds light on communicative strategies deployed by the trainers in their work in the riding hall. The focus of each of the training sessions varies depending on the rider's and the horse's respective educational level, the short and long term goals of the human participants and the current shape of rider and horse. The training sessions also vary depending on the scope of the training session (to achieve suppleness and balance in the horse (or/and the rider) or to perform a specific exercise). In coaching the riders, the trainers use a wide repertoire of verbal, paraverbal and nonverbal communicative strategies. Some of these strategies are 1) giving verbal instructions aimed at modifying the horse-rider communication (sometimes expressed in metaphors), 2) using their own bodies as models (by miming what they want the rider to do), 3) moving around in the riding hall (miming aspects such as rhythm, pace and direction), 4) intervening physically by for instance altering the posture of the rider, the position of parts of the rider's body or showing the correct degree of pressure to be applied in a certain situation and 5) mounting the horse themselves to show something from the saddle with the rider standing in the riding hall watching the trainer ride their horse. Para-verbal strategies include humming or singing in order to help the rider and the horse to relax, as well as using repetition of sound items to convey rhythm and pace. Although it seems that each trainer has his/her own favourite 'modes' of coaching, linguistic cues used to convey rhythm and pace is used by all trainers - a finding which may be explained by the prominent place rhythm and pace holds in assessing dressage riding. During the presentation, extracts from the video material will be used as illustrations of some of these findings. The extracts also show how the strategies can be combined and intertwined. Dressage riding is a complex activity, and so - the interaction analysis reveals - is dressage coaching. This study is a part of a larger study concerning communication in the horse-rider-trainer triad.

### **COACHING DRESSAGE RIDERS: A QUALITATIVE INTERVIEW STUDY EXAMINING THE CHANGING PARADIGMS OF EQUESTRIAN TRAINING**

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The proposed paper reports how coaches in dressage riding describe their methods for teaching riders to communicate with their horses, an ability which is considered paramount to an equipage's success at all levels of dressage test riding. The dominating description of dressage riding is anchored in a behaviourist paradigm, where the rider is seen as a provider of signals to the horse through a combination so called aids (weight, leg, reins and voice), to which the horse responds. The rider's combination and timing of the aids is thus the focus of the training. The role of the horse is simply to react to these signals. This paradigm, together with the close ties to the uses of horses within the military, has favoured command-oriented methods in the training of horses and riders alike. However, during the last fifteen years, the interest in alternative ideas about training horses as well as when it comes to the role of the coach and their communication with the riders, has begun to grow. To begin examining how this shift-in-process affects dressage training today, data has been collected through semi-structured, in-depth interviews with five dressage coaches. Transcriptions of the interviews have been analysed from a phenomenographical perspective, an approach favouring qualitative investigations of how people experience and think about a phenomenon. The analyses reveal that the coaches work within a field of tensions between ideas pertaining from different theories on learning as well as different 'horseologies' (a term which we introduce to describe ideas about the role of the horse, about how horses learn and about horse-human relations which form an ideological core in the various traditions within the equestrian communities). All coaches stress that their primary task and goal is to improve the riders' ability to communicate with their horse and thus to improve their 'equestrian feel'. They also point to the importance of involving the rider in the communicative work of the coaching situation. Some seem to be basing their work more firmly on the traditional understanding of the role of the horse as an object responding to the rider's signals, whereas others emphasize a somewhat more symmetrical relation, where the rider's role is that of a guide rather than that of a commander. In the coaches' accounts of their training practices, adaptations to the needs of each equipage are also central. Such adaptations take into account aspects such as the equipage's educational level, the short- and long term development goals and the current shape of horse and rider alike. The study reported in this paper is a part of a larger study concerning communication in the horse-rider-trainer triad.

## Oral presentations

### OP-PM12 Thermoregulation II

#### PRACTICAL COOLING STRATEGIES ENHANCE ENDURANCE RUNNING PERFORMANCE AND INCREASE SKELETAL MUSCLE ACTIVATION

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1: ASSET LABORATORY UON (Ourimbah, Australia), 2: ISPAR UOB (Bedford, UK), 3: PRC PAN UON (Callaghan, Australia) Introduction Endurance exercise performance is impaired in hot compared to temperate conditions. Researchers have typically experimented with cooling the body prior to (pre-cooling) and during exercise (mid-cooling) to minimize such performance decrements. There has been much debate about the mechanisms that cause early fatigue in the heat and the maintenance of performance with cooling. Exercise in the heat has been shown to decrease skeletal muscle activation in an anticipatory manner to ensure thermal homeostasis (Tucker et al., 2004). Others have argued exercise in the heat is impaired due to lowered oxygen delivery to the skeletal muscles (Cheuvront et al., 2010). It is currently unclear if practical cooling strategies alter muscle activation or oxygenation. Methods In a randomised, cross-over design, nine trained male runners performed familiarisation then three 5 km running time trials on a non-motorised treadmill in hot conditions (32.5±0.1°C). The trials consisted of control (CON), pre-cooling (PRE) by cold-water immersion (24°C for 30 min) or mid-cooling (MID) by intermittent facial water spray (1 spray.km<sup>-1</sup>). Selected physiological responses were measured throughout each trial. Results Performance time was significantly faster in both PRE (24.5±2.8 min; p=0.01) and MID (24.6±3.3 min; p=0.01) compared to CON (25.2±3.2 min), but no differences were observed between PRE and MID (p=0.66). Summated integrated electromyography was significantly higher in PRE (2.36±0.55 V.s<sup>-1</sup>; p=0.03) and MID (2.24±0.55 V.s<sup>-1</sup>; p=0.03) when compared to CON (2.06±0.44 V.s<sup>-1</sup>). Forehead temperature was significantly lower in PRE and MID compared to CON (p<0.05). Cold-water immersion significantly reduced rectal temperature by 0.5°C and remained lower throughout the trial. There were no significant changes in heart rate, VO<sub>2</sub> or tissue saturation index. Discussion Self-paced endurance running performance was improved by a similar magnitude (~3%) with cold-water immersion and intermittent facial water spray. Both interventions lowered forehead temperature, increased muscle activation and increased running speed predominantly in the first half of the time trial. Hence, it is proposed that the cooling interventions delayed any anticipatory reduction in skeletal muscle activation until heat storage surpassed a threshold mid-way through the running time trial. There was no evidence of improved cardiovascular or peripheral metabolism efficiency with either intervention. References Cheuvront S, Kenefick R, Montain S, Sawka M. (2010). *J Appl Physiol*, 109(6), 1989-1995. Tucker R, Rauch L, Harley Y, Noakes T. (2004). *Pflugers Archiv*, 448(4), 422-430. Contact christopher.j.stevens@uon.edu.au

#### SELF-PACED EXERCISE IS REGULATED BY THE MAINTENANCE OF %VO<sub>2</sub>PEAK WITHIN A NARROW RANGE IN HOT AND COOL CONDITIONS

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Introduction A decrease in peak oxygen uptake (VO<sub>2</sub>peak) has been suggested to regulate self-paced exercise in the heat by mediating adjustments in absolute workload (i.e. power output) to maintain relative exercise intensity (i.e. %VO<sub>2</sub>peak) within a narrow range (Cheuvront et al., 2010; Périard et al., 2011). However, the time course and extent of decrease in VO<sub>2</sub>peak have yet to be determined. Thus, we examined these parameters during self-paced exercise in HOT (35°C and 60% RH) and COOL (18°C and 40% RH) conditions. Methods Ten well-trained cyclists completed four consecutive 16.5 min time trials (15 min self-paced effort followed by 90 s maximal end-spurt to determine VO<sub>2</sub>peak) interspersed by 5 min of recovery in each condition. Results Rectal temperature increased significantly more in HOT (39.4 ± 0.7°C) than COOL (38.6 ± 0.3°C; P<0.001), while heart rate was higher throughout HOT (P<0.05), and ratings of perceived exertion higher during trials three and four in HOT (P<0.05). Power output was lower throughout HOT compared with COOL (P<0.05). The decrease in power output from trial one to four was ~15% greater in HOT (P<0.001). VO<sub>2</sub> was lower in HOT than COOL except at 5 min and during the end-spurt in trial one (P<0.05). In HOT, VO<sub>2</sub>peak reached 96, 89, 87 and 87% of pre-determined VO<sub>2</sub>max, whereas in COOL 97, 95, 93 and 92% was attained. %VO<sub>2</sub>peak was similar between conditions during trials one and two, and lower in HOT during trials three and four (P<0.05), yet heart rate and perceived exertion were higher. Discussion Pacing is a process informed by prior experience, accurate knowledge of a task, an understanding one's abilities, and the interpretation of physiological cues (sensory information) associated with effort. However, it is influenced by a variety of factors (e.g. hyperthermia, neuromuscular function, and metabolism) (Edwards & Polman, 2013; Nybo et al., 2014). Under heat stress, the primary determinant mediating the impairment in performance appears to stem from a thermal strain-mediated rise in cardiovascular strain. Indeed, self-paced exercise appears to be regulated by the maintenance of %VO<sub>2</sub>peak within a narrow range (±2%), which widens (±7%) under heat stress when exercise becomes protracted. This occurs as a disassociation develops between %VO<sub>2</sub>peak, heart rate and ratings of perceived exertion, due to factors associated with temperature regulation, autonomic control, and intrinsic heart rate. References Cheuvront SN, Kenefick RW, Montain SJ & Sawka MN. (2010). *J Appl Physiol* (1985), 109, 1989-1995. Edwards AM & Polman RC. (2013). *Sports Med*, 43, 1057-1064. Nybo L, Rasmussen P & Sawka MN. (2014). *Compr Physiol*, 114: 1789-1799. Périard JD, Cramer MN, Chapman PG, Caillaud C & Thompson MW. (2011). *Exp Physiol*, 96, 134-144. Contact Julien.periard@aspetar.com

#### HEAT ACCLIMATION ATTENUATES PHYSIOLOGICAL STRAIN IN ACUTE NORMOBARIC HYPOXIA

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1 Centre for Sport and Exercise Science and Medicine, University of Brighton, UK. 2 English Institute of Sport, EIS Performance Centre, Loughborough, UK. Introduction Heat acclimation (HA) attenuates physiological strain in hot, humid conditions with evidence supporting HA as an intervention to improve exercise capacity in both temperate and hot conditions. Emerging hypotheses also support reductions in physiological strain and exercise capacity at altitude following thermal interventions. The aim of this study was to determine whether HA reduced the physiological strain in acute normobaric hypoxia. Methods Sixteen males (age 24 ± 5 yr, mass 74.6 ± 6.3 kg, VO<sub>2</sub>peak 4.27 ± 0.63 L.min<sup>-1</sup>) completed ten, 90 min sessions of HA (40°C/40% relative humidity (RH)) or exercise training (EX; 20°C/40% RH) on

cycle ergometers. HA or EX were preceded (HYP1) and proceeded (HYP2) by a normobaric hypoxic exposure ( $FI_{O_2} = 0.12$ ; 10 min of rest, 10 min cycling at 40% $VO_{2peak}$ , 10 min cycling at 65% $VO_{2peak}$ ) with measurement of heart rate (HR), and calculation of stroke volume (SV), cardiac output (Q) and respiratory exchange ratio (RER) utilising online metabolic gas exchange. Plasma volume (PV) and haemoglobin mass (Hbmass) were measured utilising the oCOR-method. Results HA reduced resting rectal temperature (T<sub>rec</sub>; Day1 37.0 ± 0.2°C; Day10 36.5 ± 0.3°C;  $p < 0.001$ ), HR (Day1 74 ± 13 b.min<sup>-1</sup>; Day10 56 ± 8 b.min<sup>-1</sup>;  $p < 0.001$ ) and increased PV (+15.4 ± 9.2%;  $p < 0.001$ ). No changes in resting T<sub>rec</sub> (Day1 37.0 ± 0.3°C; Day10 36.9 ± 0.3°C;  $p = 0.522$ ), HR (Day1 68 ± 14 b.min<sup>-1</sup>; Day10 66 ± 9 b.min<sup>-1</sup>;  $p = 0.398$ ), or PV (+1.8 ± 5.0%;  $p = 0.622$ ) were observed following EX. No change ( $p > 0.05$ ) was observed in Hbmass following HA (Pre 869 ± 92 g; Post 869 ± 96 g), or EX (Pre 865 ± 110 g; Post 857 ± 126 g). SV in hypoxia was greater at rest (HYP1 74.9 ± 15.3 mL; HYP2 83.5 ± 16.8 mL;  $p = 0.002$ ), 40% $VO_{2peak}$  (HYP1 113.5 ± 15.1 mL; HYP2 121.2 ± 9.9 mL;  $p = 0.049$ ) and 65% $VO_{2peak}$  (HYP1 107.6 ± 12.6 mL; HYP2 119.4 ± 7.8 mL;  $p < 0.001$ ) following HA, but was unchanged after EX ( $p > 0.05$ ). HR in hypoxia was lower (HYP1 168 ± 14 b.min<sup>-1</sup>; HYP2 158 ± 13 b.min<sup>-1</sup>;  $p = 0.001$ ) and oxygen saturation higher (HYP1 73 ± 3%; HYP2 76 ± 3%;  $p = 0.006$ ) at 65% $VO_{2peak}$  following HA, but not EX ( $p > 0.05$ ). Q in hypoxia was unchanged in EX or HA ( $p > 0.05$ ). RER reduced at rest in hypoxia (HYP1 0.96 ± 0.07; HYP2 0.90 ± 0.06;  $p = 0.045$ ) following HA, but not EX ( $p > 0.05$ ). Discussion HA is an effective intervention for reducing physiological strain associated with acute normobaric hypoxia, in part through HA derived PV expansion improving cardiac efficiency. Further research is required to determine the benefits of cross-acclimation across a spectrum of simulated and actual altitudes, whilst implementing different work prescription, including performance trials. Contact o.r.gibson@brighton.ac.uk

## THE EFFECT OF USING DIFFERENT REGIONS OF INTEREST ON LOCAL AND MEAN SKIN TEMPERATURE

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**Introduction** The dynamic nature of tissue temperature and the subcutaneous properties, such as blood flow, fatness, and metabolic rate, leads to variation in local skin temperature. Therefore, we investigated the effects of using multiple regions of interest when calculating weighted mean skin temperature from four local sites. **Methods** Twenty-six healthy males completed a single trial in a thermoneutral laboratory (mean ± SD): 24.0 (1.2) °C; 56 (8%) relative humidity; < 0.1 m/s air speed). Mean skin temperature was calculated from four local sites (neck, scapula, hand and shin) in accordance with International Standards using digital infrared thermography. A 50 x 50 mm square, defined by strips of aluminium tape, created six unique regions of interest, top left quadrant, top right quadrant, bottom left quadrant, bottom right quadrant, centre quadrant and the entire region of interest, at each of the local sites. The largest potential error in weighted mean skin temperature was calculated using a combination of a) the coolest and b) the warmest regions of interest at each of the local sites. Results Significant differences between the six regions interest were observed at the neck ( $P < 0.01$ ), scapula ( $P < 0.001$ ) and shin ( $P < 0.05$ ); but not at the hand ( $P = 0.482$ ). The largest difference (± SEM) at each site was as follows: neck 0.2 (0.1) °C; scapula 0.2 (0.0) °C; shin 0.1 (0.0) °C and hand 0.1 (0.1) °C. The largest potential error (mean ± SD) in weighted mean skin temperature was 0.4 (0.1) °C ( $P < 0.001$ ) and the associated 95% limits of agreement for these differences was 0.2 to 0.5 °C. **Discussion** Despite finding statistically significant differences in neck, scapula and shin, the magnitude of variation at each of these sites was negligible (< 0.3 °C) in healthy young males at rest in a thermoneutral environment. Furthermore, these variations did not introduce a clinically meaningful error (> 0.5 °C) in mean skin temperature. However, further research examining the influence of using different regions of interest to calculate skin temperature during exercise in high ambient environments is warranted.

## HUMAN METABOLIC RESPONSE IN VERY COLD ENVIRONMENT AND ANTARCTICA

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Our ancestors survived in an unforgiving environment dominated by ice ages. Nevertheless, because climate change is considered to be one of the largest threats to humanity in the future, how to survive the next ice age is an important topic for study. Humans have evolved the function of sustaining constant temperature in a variety of circumstances. To survive in extreme environments, the body has to adapt physiologically. When the body is repeatedly exposed to different environments, resistance to new stress is increased. In cold-exposed adult humans, significant decreases in body temperature are delayed by reducing rates of heat loss via peripheral vasoconstriction and by increasing rates of heat production via shivering and non-shivering thermogenesis. Shivering is elicited by exposure to cold air and this can increase the resting metabolic rate. Fuel selection mechanisms are responsible for sustaining shivering thermogenesis. It has been reported that over a 3-month trip in Antarctica, subjects lost more than 25% of body weight, despite an average energy intake of 21.3MJ/day (Stroud et al. 1997). However, the adaptation process of the biological systems of humans to Antarctic and other cold environments is not well understood. Cold environments have many different effects on the body, such as pronounced metabolic changes, and we are especially interested in physiological adaptations under those conditions. We are currently studying how cold stress affects human metabolism, carried out in a -15°C cold room and Antarctic environment. The results of this study showed that acute cold environment at -15°C increased resting metabolism and fat oxidation, but carbohydrate oxidation was not influenced. Extreme shivering appeared in some subjects during cold exposure -15°C, but not in all subjects. For psychological stress activities, the levels of s-amylase activity and cortisol showed a significant increase in -15°C. Further investigations are needed to optimize nutrients and energy balance for extreme cold or Antarctic environment and to understand the mechanism underlying the combined effects of physiological and neurological responses to extreme cold stress.

## COVERT OR OVERT CHEMICAL/BIOLOGICAL PROTECTIVE CLOTHING SYSTEM: A PHYSIOLOGICAL COMPARISON IN EXTREME ENVIRONMENTS

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**Introduction** Ensuring protection of state and national dignitaries means that security personnel are prepared to deal with multiple risks including: arms fire, explosions and/or chemical/biological threats. These security personnel are required to maintain vigilance for extended periods often in challenging environments, as observed recently in Brisbane Australia during the G20 summit where ambient temperatures exceeded 40°C. The combination of a challenging environment and the encapsulating protective clothing may impair heat loss and place the security personnel at risk of heat injury. Therefore, the aim of this study was to compare the physiological tolerance times while wearing a covert or overt chemical/biological protective clothing ensemble, in simulated environmental extremes. **Methods**

Eight healthy males undertook four trials while wearing a Chemical/Biological Protective Clothing System plus flight suit (cover) or an Extended Response Suit (overt) and respirator. These ensembles are certified as Class 3 protection by the National Fire and Protection Association (USA). The trials involved walking on a treadmill at 4 km.h<sup>-1</sup> at 1% grade in 21 and 37°C wet bulb globe temperature (WBGT) environmental conditions, in a randomized controlled crossover design. The trials were ceased if the participants' core temperature reached 39°C, if heart rate exceeded 90% of maximum, if walking time reached 60 minutes or due to fatigue/nausea. Tolerance times were analysed using a two-way (ensemble x environment) repeated measures analyses of variance. Results Significant main effects ( $p < 0.01$ ) were observed in ensemble, environment, and their interaction. Post hoc analysis showed tolerance times in WBGT 21°C were longer than WBGT 37°C (mean $\pm$ sem; 120 $\pm$ 0.0 and 42.8 $\pm$ 1.5 min,  $p < 0.01$ ), and in the covert compared with the overt ensembles (84.2 $\pm$ 0.8 and 78.6 $\pm$ 0.9 min,  $p < 0.01$ ). At WBGT 37°C the tolerance time in the covert were significantly longer than the overt (48.4 $\pm$ 1.6 and 37.3 $\pm$ 1.9 min,  $p < 0.01$ ). There was no difference in tolerance time at WBGT 21°C with all participants in both ensembles reaching the maximum duration of 120min. Core temperature was the termination criteria in 100% of participants in the covert and 75% of participants in the overt trials at WBGT 37°C. Discussion In conclusion, participants were able to wear Class 3 chemical/biological protective clothing ensembles in WBGT21°C conditions for in excess of 120 mins. In the extreme ambient conditions of WBGT37°C both ensembles displayed significantly reduced tolerance times, with the covert ensemble enabling a longer total duration in comparison to the overt ensemble, before participants' core temperatures reached 39°C. Security personnel required to wear chemical/biological protective clothing ensembles should remain cognisant of the environmental conditions and the total time they remain encapsulated. Contact i.stewart@qut.edu.au

## Oral presentations

### OP-PM49 Training & Testing: Age & Clinical

#### AEROBIC FITNESS, STRENGTH AND RATE OF FORCE DEVELOPMENT IN SIMVASTATIN TREATED SUBJECTS WITH OR WITHOUT MYALGIA.

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Introduction: Simvastatin is a cholesterol-lowering drug widely used in primary prevention and in treatment to reduce risk of cardiovascular disease. The most prominent adverse effect reported with the use of statins is muscle weakness/ache known as myalgia. To what extent this affects daily living including physical activity levels is not clear. The role of myalgia in regards to physical activity with statin treatment is debated and the impact the two have upon each other is not fully understood. In this cross-sectional study we aim to elucidate whether or not there is a difference in the fitness level, the strength or the rate of force development (RFD) in Simvastatin treated groups with or without myalgia. Methods: 60 comparable subjects in primary prevention using Simvastatin 40mg daily for at least 3 months will be enrolled into two groups of 30 with or without myalgia, respectively. On separate days subjects perform a graded incremental VO<sub>2</sub>max-test on a cycle ergometer, a test of maximal power output (MVC) using a Leg Extensor Power Rig, a test of RFD at different time intervals (0-30 ms, 0-50 ms, 0-100 ms and 0-200 ms) during isometric knee-extension using a Kin-Com Dynamometer, and a test of grip-strength using a Grip Strength Dynamometer. The self-reported myalgia is estimated using a visual analog scale (VAS) and daily physical activity is assessed using the International Physical Activity Questionnaire (IPAQ). Body composition is measured by DXA and anthropometric data are sampled to characterize and compare the groups. Results: So far 18 subjects have completed the study, 10 with myalgia (5 M/5 F; age 59.7  $\pm$  1.8 yrs; weight 90  $\pm$  7.2 kg; BMI 29.5  $\pm$  1.9; lean body mass 52.5  $\pm$  3.8 kg) and 8 without myalgia (5 M/3 F; age 59.5  $\pm$  2.6 years; weight 86.9  $\pm$  6.5 kg; BMI 28.7  $\pm$  1.8; lean body mass 55.4  $\pm$  4.4 kg). There were no differences in VO<sub>2</sub>max ( $p = 0.3$ ), MVC ( $p = 0.5$ ) or grip-strength ( $p = 0.5$ ) between the groups. There was a trend towards higher RFD in the group with myalgia at 0-30 ms and 0-50 ms ( $p = 0.08$  and  $p = 0.06$ , respectively). VAS was as expected significantly higher in the group with myalgia (4.5  $\pm$  0.8 and 0.5  $\pm$  0.4,  $p = 0.5$ ). The IPAQ showed no difference ( $p = 0.24$ ). Discussion: Although myalgia is often reported as an adverse effect when using Simvastatin, this study did not find any differences in aerobic fitness, muscle strength or function. This study is not fully completed and may yet show a different result upon completion. The trend towards higher RFD in the group with myalgia could suggest that myalgia per se does not reflect impaired muscle function. Email address: Thomasmor@sund.ku.dk

#### ACUTE PHYSIOLOGICAL RESPONSES TO NOVEL HIGH-INTENSITY INTERVAL TRAINING IN OLDER ADULTS

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Introduction Traditionally, high-intensity interval training (HIT) has been confined to the laboratory, with cycle ergometry the preferred exercise mode (Weston et al., 2014). Alternative HIT strategies suitable for a range of populations, including older adults, should therefore be explored. A recently developed double-concentric (d-c) multi-joint exercise device offers the potential to elicit a high-intensity physiological response. As such the aim of our study was to assess the viability of the d-c device, in comparison to cycle ergometry, as a mode of HIT. Methods In a randomised crossover design, 20 healthy older adults (10 females; age range 55-76 y) completed a HIT protocol, consisting of 3 sets of 4 repetitions on two different exercise modes; cycle and d-c device. Each set consisted of a 75, 60, 45 and 30-s HIT repetition followed by a passive recovery (1:1 work:rest ratio), with each set interspersed with 2-min passive rest. During cycling, the resistance was 80% of peak power attained during a maximal, incremental cycle test, with a self-determined cadence corresponding to a rating of perceived exertion (RPE) of 7 (CR10 scale; 'very hard'). In the absence of fixed resistance for the d-c device, participants exercised at the same level of perceived exertion and completed 4 multi-joint exercises per set (squat, power clean and press, pulldown to squat and step and press). Heart rate (HR) and expired gas were collected continuously throughout exercise, with blood lactate (BLa) measured following each set. Mean difference ( $\pm$ 95% confidence limits) between protocols was then derived. Using a linear mixed model (random slope and intercept) we derived the within-subject standard error of the estimate (SEE) for predicting cycle HIT physiological response from d-c response. Data are mean  $\pm$  SD. Results For all measures there were no substantial differences in HIT physiological response between cycle and d-c: HRmean (81.7  $\pm$  8.2%HRmax vs 82.5  $\pm$  7.2%HRmax, mean difference -0.8 [ $\pm$ 95% confidence limits 3.1] percentage points), HRpeak (89.7  $\pm$  7.3%HRmax vs 90.1  $\pm$  6.7%HRmax, -0.4 [ $\pm$ 2.6] percentage points), VO<sub>2</sub>peak (84.5  $\pm$  10.6% vs 82.8  $\pm$  11.2%, 1.7 [ $\pm$ 5.6] percentage points) and BLa (5.5  $\pm$  1.7 mmol vs 5.3  $\pm$  1.7 mmol, 0.2 [ $\pm$ 0.9] mmol). The within-subject SEE for HRmean, HRpeak, VO<sub>2</sub>peak and BLa was 3.8% ( $\pm$ 95% confidence limits  $\pm$ 0.4%), 4.1% ( $\pm$ 0.4%), 5.1% ( $\pm$ 0.5%) and 2.7% ( $\pm$ 1.2%). Discussion The d-c device elicited a

high-intensity physiological response consistent with cycle ergometry, suggesting it to be a viable HIT mode in older adults. Future work should examine the effectiveness of the double-concentric muscle contractions elicited by the d-c device as a mode of strength/power training in older adults. References Weston et al. (2014). *Sports Med* 44(7), 1005-17 Contact c.hurst@tees.ac.uk

### EMG-THRESHOLD DETECTION COMPARED WITH THE INDIVIDUAL ANAEROBIC LACTATE THRESHOLD

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**Introduction** Besides approaches using lactate or oxygen consumption, there are electromyographical (EMG) attempts to detect breakpoints during incremental tests. An advantage of EMG thresholds is that they could provide individual muscle-specific feedback during all out tests[3]. The purpose of this pilot study was to compare the individual anaerobic lactate threshold (IAT)[4] with thresholds determined by using the course of the amplitude (root mean square, RMS)[3] and frequency (Mean Power Frequency, MPF)[1] of the EMG signal during exercise on a cycle ergometer. **Methods** Six subjects (16+/-0,8 years) performed incremental exercise on a cycle ergometer. The EMG was recorded from the rect.fem.(RF), vast.lat.(VL), vast.med.(VM) and gastroc.med.(GM) of both legs. A ten second interval was used for the calculation of the EMG-RMS. The course of the MPF was calculated using the average of two manually defined contractions during ten second timeframes. IAT and breakpoints (Muscle Turn Point, MTP) in the EMG-RMS and MPF signals were detected visually by independent and blinded peers. Possible differences between MTP-RMS and MTP-MPF to the IAT thresholds were tested with paired t-tests. Relations between MTP-RMS vs IAT and MTP-MPF vs IAT were verified by Person's correlation coefficients and Bland-Altman Plots. Results MTP-RMS were very well detectable in almost all experiments in VL (100%), RF (91,5%), and VM (83%). Similarly, MTP-MPF were detectable in VL (91,5%), RF (100%) and VM (75%). However, it was barely possible to detect thresholds at the GM. There was no significant difference between the metabolic threshold IAT and the MTP-RMS and MTP-MPF ( $p > 0,05$ ). Mean to good correlations could be detected. MTP-RMS vs IAT (RF:d:0,78;VMd:r=0,67;VLd:r=0,74; RFs:r=0,64;VMs:r=NA;VLS:r=0,75) MTP-MPF vs IAT (RFd:r=0,52;VMd:r=0,90;VLd:r=0,88; RFs:r=0,85;VMd:r=NA;VLd:r=0,86;d=dexter;s=sinister). **Discussion** The determination of the breakpoints using EMG-RMS and EMG-MPF turned out to be a valid method to detect muscle-specific transitions to anaerobic metabolism. Our results match to those in the literature[1] although the detection using the amplitude (RMS) signal seems a more reliable method. For future studies we propose to measure the metabolic thresholds directly at or close to the muscle to discover whether the EMG thresholds fit with the muscle-specific metabolic thresholds. **References** [1] Helal, J. N., Guezennec, C. Y., Goubel, F. (1987). *Eur J Appl Physiol* 56(6), 643-649. [2] Jürimäe, J., von Duvillard, Serge P, Mäestu, J., Cicchella, A., Purge, P., Ruosi, S., Hamra, J. (2007). *Eur J Appl Physiol*, 101(3), 341-346. [3] Lucia, A., Sánchez, O., Carvajal, A., Chicharro, J. L. (1999). *B J Sports Med*, 33(3), 178-185. [4] Pessenhofer, H., Schwaberg, G., Schmid, P. (1981), *DZSM*, 32 (1), 15 - 7.

### END CRITERIA FOR REACHING MAXIMAL OXYGEN UPTAKE IN 13 YEAR OLD BOYS AND GIRLS

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**Introduction** Maximal oxygen uptake ( $VO_{2max}$ ) has long been regarded as the gold standard for measurements of aerobic fitness. Several end criteria are commonly used both in adult and younger populations. The present study aimed to describe how many adolescents fulfilled different end criteria for reaching  $VO_{2max}$  during a graded maximal treadmill test to voluntary exhaustion. **Methods** Sixty-nine healthy 13-years old adolescents performed maximal running on a treadmill. Heart rate (HR), ventilation (VE), respiratory exchange ratio (RER) and oxygen uptake ( $VO_2$ ) was recorded continuously. Perceived exertion (RPE) was reported using the Borg Scale 6-20. The test ended when the participants could no longer keep up with the treadmill or they had reached his or her maximal effort. The different end criteria analysed were peak RER  $\geq 1.0$ ,  $VO_{2plateau}$  and  $VO_{2levelling}$  off, peak RPE  $\geq 17$  and HRmax  $\geq 95\%$  of the age-predicted HRmax (208-0.7age).  $VO_{2plateau}$  were defined as no increase in  $VO_2$  despite increase in ventilation during the last two minutes.  $VO_{2levelling}$  off were defined as no more than 2ml increase in  $VO_2$  during the last two minutes. Data are presented as mean values  $\pm$  standard deviation. Multiple t-tests were used to evaluate the effect of the end criteria on  $VO_{2max}$ , when applicable. Statistical tests were conducted using GraphPad Prism 6.0f (GraphPad software, La Jolla, CA, USA). P values of  $\leq 0.05$  were considered statistically significant. Results The average  $VO_{2max}$  was  $54 \pm 9$  ml $\cdot$ kg $^{-1}$  $\cdot$ min $^{-1}$ .  $VO_{2max}$  and VEpeak were 13% ( $57 \pm 10$  vs.  $50 \pm 7$  ml $\cdot$ kg $^{-1}$  $\cdot$ min $^{-1}$ ) and 12% ( $100 \pm 18$  vs.  $89 \pm 10$  L $\cdot$ min $^{-1}$ ) higher in the boys compared to girls ( $p < 0.05$ ). Common end criteria in children, RER  $\geq 1.0$  and RPE  $\geq 17$  were fulfilled by 93% and 99%, respectively. Only 9% achieved a true plateau in  $VO_2$  during the last two minutes of the test, whereas 52% achieved a levelling off in  $VO_2$  during the same time period. Thirty-five percent reached HRmax  $\geq 95\%$  of the age-predicted HRmax. The end criteria had no significant impact on  $VO_{2max}$  except for RER  $\geq 1.0$  in which a higher  $VO_{2max}$  ( $64 \pm 9$  vs  $53 \pm 9$  ml $\cdot$ kg $^{-1}$  $\cdot$ min $^{-1}$ ) was observed in those who did not reach this end criterion. **Discussion** The strict definition of  $VO_{2plateau}$  seems to be untenable, as only 9% achieved this criterion. In contrast, 93 percent achieved RER  $\geq 1.0$  and 99% achieved  $\geq RPE \geq 17$ . Voluntary exhaustion and RER  $\geq 1.0$  and RPE  $\geq 17$  seems to be efficient end criteria for 13 years old adolescents as stricter criteria did not result in higher  $VO_{2max}$  values. Contact Ken.J.Hellelid@uia.no

### LUMBAR JOINT POSITION SENSE AND LUMBAR RANGE OF MOVEMENT TEST USING ELECTROGONIOMETER: RELIABILITY STUDY WITH ACTIVE STUDENTS AND HIGH LEVEL SWIMMERS

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**Introduction** Joint position sense (JPS) and lumbar range of movement (ROM) has been used to measure proprioception and evaluate biomechanics of the lumbar spine both in sports men and sedentary people. The spine reposition sense methods use to be very expensive and difficult to manage. The methods to accurate measure of lumbar ROM still use x ray, assuming that the most accurate method is the most aggressive too. Electrogoniometer hasn't been measured lumbar JPS and ROM. Therefore, the aim of this study was to determine the reliability of lumbar joint position sense and lumbar ROM test using electrogoniometer in a seated position in active students and professional swimmers. **Methods** A sample of thirty-four healthy professional swimmers (20.3 $\pm$ 4.1 years) and twenty-seven healthy active students (22.8 $\pm$ 2.9 years) participated in the study. Lumbar ROM was measured in the lumbar spine, summing absolute values of maximal flexion and extension target angles. JPS was measured by Absolute errors, defined by the difference between the absolute value of the perceived mid position and the real mathematical half position. Reliability was determined by the reproducibility or stability on both test-retest data, comparing the scores between 3 trials of each variable on 2 different days, separate by 2-3 days. Intratester reliability was determined by comparing the obtained data by the same tester across 2 different days. **Results** The electrogoniometer was found to

be reliable instrument as both test ( $p=0.999$ ) and retest ( $p=0.999$ ) Intraclass correlation coefficients (ICC) were high. The different flexion, extension and total ROM tested and lumbar position sense were also found to be reliable with ICC ranging from 0.895 to 0.991. No differences were observed between trials for either measure. Intratester reliability was warranted by the application of the same protocol by the same tester during all data collection. Discussion There is a strong relationship between the obtained data with previous lumbar spine studies (Lee et al., 2002; Maduri & Wilson 2009). The results suggest that the electrogoniometer is a reliable and valid instrument to measure the lumbar sagittal ROM and the lumbar position sense on seated position. It could be an easy and less sophisticated way to improve lumbar proprioception and kinematic researches (Ha et al., 2013). Further research is needed to identify the specific mechanism of proprioception during flexion and extension tasks and to establish the concept of relative error instead of absolute error to make a relationship between JPS and total ROM. References Ha, T. H., Saber-Sheikh, K., Moore, A. P., & Jones, M. P. (2013). Measurement of lumbar spine range of movement and coupled motion using inertial sensors - A protocol validity study. *Manual Therapy*, 18(1), 87–91. Lee, R. (2002). Measurement of movements of the lumbar spine. *Physiotherapy Theory and Practice*, 18(4), 159–164. Maduri, A., & Wilson, S. E. (2009). Lumbar position sense with extreme lumbar angle. *Journal of Electromyography and Kinesiology*, 19(4), 607–613.

### RELIABILITY OF OBJECTIVELY MEASURED SEDENTARY TIME AND PHYSICAL ACTIVITY IN ADULTS

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Purpose: To determine the reliability of objectively assessed sedentary behavior (SED) and physical activity (PA) in an adult population. Methods: Eighty-seven adult subjects (28 men; mean (standard deviation) age 31.3 (12.2) years; body mass index 23.7 (3.1) kg/m<sup>2</sup>) wore the GT3X+ accelerometer for 21 subsequent days, for which the reliability of different wear time criteria (8 to 12 h/day and 3 to 5 d/week) was explored. Variance partitioning along with the Spearman-Brown prophecy formula was used as the basis for determining intraclass-correlation coefficients (ICC) and the number of monitoring days needed (N) to achieve an ICC = 0.80. Week-by-week reliability was reported using ICC, Bland-Altman plots and absolute measures of agreement. Results: Seven-10 days of monitoring was needed to reliably assess overall- (axis 1 and vector magnitude (VM) counts per minute (CPM)) and moderate-to-vigorous PA (MVPA), 3-4 days was needed for light PA (LPA), whereas the number of days needed for SED depended on whether adjustments were made for wear time (6-8 days) or not (13-16 days). The week-by-week ICC was  $\geq 0.70$  for all variables, with limits of agreement being  $\pm 267.8$  cpm for CPM,  $\pm 352.3$  cpm for VM CPM,  $\pm 76.8$  min/day for SED,  $\pm 57.8$  min/day for LPA and  $\pm 43.8$  min/day for MVPA, when adjustment was made for wear time. Conclusions: For most variables, more than one week of measurement was needed to achieve an ICC = 0.80. Correcting for wear time was crucial to reliably determine SED. Considerable week-by-week variability was found for all variables. Researchers need to be aware of substantial intra-individual variability in accelerometer-measurements.

## Oral presentations

### OP-BN03 Swimming, Jumping & Squatting, Coordination

#### PRESSURE DISTRIBUTION ON SWIMMING HANDS WITH FINGER SPREADING

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It is known that a spreading of fingers during swimming has a favorable effect on the drag coefficient, which can enhance propulsion in swimming [1]. The drag coefficient CD represents the effect of the hand shape in relation to the drag force. The change in geometry changes the flow and subsequently CD. Hence, an increase in CD implies smaller losses in power during a swim stroke. Both experiments and numerical simulations were carried out. The experiments were carried out in a wind tunnel, using solid plates that were cut according to a traced circumference of actual hands with different finger spreading. The hands were placed inside a wind tunnel with the plane of the hands normal to the flow velocity. Wind speed was adjusted so that the air flow corresponds to the flow Reynolds number in water ( $Re=30000$ ). We tested both a closed and hands with finger spreading between 2 and 15 mm. It was found that the drag coefficient increases by about 3% at a 5-10 mm finger spreading, in agreement with previous results [1]. It is noted that spreading fingers also increases the hand frontal surface area, resulting in a net effect of 10% higher CD. CFD was performed on the same hand models, providing the pressure distribution over the front and back surfaces of the hands, in relation to the observed changes in drag coefficient. The results of these simulations provides information on the flow that causes the increase in CD, but also how a swimmer perceives the forces on the fingers. Also, the results provide clues on where to measure forces and pressures for quantitative feedback to swimmers. Reference: 1. Marinho et al., J. Appl. Biomech. 26 (2010) 87 Contact: J.Westerweel@tudelft.nl

#### THE EFFECTS OF A COMPUTERIZED BIOMECHANICAL ANALYSIS AS A TEACHING STRATEGY ON THE RECOVERY SHOULDER OF THE FRONT CRAWL SWIMMING

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This study was computed to test for significance of the effects of three teaching strategies on the humerus of rotation and linear displacement of the breathing and non-breathing recovery arms of the front crawl swimming. Seventy registered Iran Swimming boys and girls between the ages of 8 through 12 years were given "intact groups" assignment. The participants were selected from Shiraz Swimming teams. The study included 25 participants for each of the following four groups: (1) control, (2) traditional teaching strategy, (3) traditional and videotape teaching strategy, and (4) traditional and System computerized biomechanical analysis teaching strategy. Participants were individually videotaped while swimming 25 meters of the front crawl swimming. Measurements from the radius of rotation and linear displacement of the radius and glenohumeral joint segment were calculated by the NEAT System software. It was determined that all treatments effected increase in radius of rotation and linear displacement. Therefore, all of the teaching strategies caused significant improvement in the radius of rotation and linear displacement for the breathing recovery arm of front crawl swimming. Physiological benefits included enhanced awareness of correct shoulder elevation that could improve swimming skill and swimming times. Psycholog-

ical benefits might have included increased self-concept. Benefits also included knowledge of better teaching strategies such as computerized biomechanical analysis to enhance motor learning.

### UNSTEADY AERODYNAMICS OF A SKI JUMPER DURING THE TAKEOFF MOTION

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**Introduction** The ski jumping takeoff motion is the transition movement from the in-run posture to the flight posture. The aerodynamic force acting on a ski jumper varies dynamically because of the postural change in a short period. The ski jumper must perform an appropriate takeoff movement for an aerodynamic force to form a suitable flight posture (Schwameder, 2008). However, force measurement during the motion does not yet lead to quantification. This study was designed to quantify the aerodynamic characteristics during takeoff using computer fluid dynamics (CFD). **Methods** The CFD method adopted for this study is based on Large-Eddy Simulation. Body surface data were obtained by 3-D laser scanning of an active ski jumper. A model was generated by dividing the data into 15 segments with joint mobility. Based on video analysis of the actual takeoff movement at a jumping hill, two sets of motion data were generated (world-class jumper A and less-experienced junior jumper B). The incoming velocity was set to 25 m/s. The aerodynamic force, flow velocity, and vortices for each model were compared between models. **Results** The drag force acting on jumper A was weaker than that acting on jumper B through the whole movement. Regarding the lift force, although jumper A's lift force was less in the in-run posture, it became greater than that of jumper B at the end of the movement. In the latter half of the movement, low air-speed domain expansion was observed at the model's back. This domain of jumper B was larger. The flow structure of the two models on their wake was completely different. Jumper A had two symmetric vortexes, but two disordered vortexes on both sides of the back were observed in jumper B. **Discussion** Comparison of the two models shows that aerodynamic forces acting on models might be influenced by the airflow condition around the model's back. Expansion of the low air-speed domain of jumper B can be caused by a large trunk angle of attack (Meile et al., 2006). The trunk and upper arm motion might cause the flow structure difference of the wake. Larger vortexes were formed for jumper B because wakes formed by the arms and lower limbs were united in the rear. However, the vortexes created by the arms remain at the end of the motion in jumper A because the glenohumeral joint is extended during movement. **Results** of this study suggest that the takeoff movement strongly influences airflow conditions and aerodynamic characteristics around the jumper in a short period. **References** Schwameder, H. (2008). *Sports Biomechanics*, 7(1), 114-136. Meile, W, Reisenberger, E, Mayer, M, Schmölzer, B, Müller, W, Brenn, G. (2006). *Experiments in Fluids*, 41(6), 949-964. Contact [kyamamoto@hokusho-u.ac.jp](mailto:kyamamoto@hokusho-u.ac.jp)

### SKI JUMPING: HOW DO SITTING POSITION AND JUMPING MOVEMENTS AFFECT THE VERTICAL GROUND REACTION FORCE?

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1Norwegian University of Science and Technology, Trondheim, Norway 2Olympiatoppen Midt-Norge, Trondheim, Norway 3Institute of Sport Science, University of Innsbruck, Austria **Introduction** Part of technique training in ski jumping consists of land-based simulation jumps: athletes vary their sitting posture following instructions, such as "high", "low", "offensive", or "defensive", and evaluate the subsequent jump with their coaches. This study addresses three research questions: (1) Do different athletes interpret the different instructions in similar ways? (2) What characteristic variations are seen in the sitting posture and jump kinematics? (3) How do changes in sitting posture and/or jump kinematics affect mechanical performance variables such as vertical ground reaction force (vGRF)? **Methods** Fourteen ski jumpers completed 21 jumps under 6 different conditions: perfect, high, low, offensive, defensive, and free. The sitting posture and jump were recorded with Oqus motion tracking system using 22 reflective markers distributed on the right extremities, pelvis, spine, and head. Two Kistler force plates recorded the vGRF. A principal component analysis (PCA) was performed (Federolf et al. 2013) on a combination of marker trajectories and vGRF waveforms. We assessed how changes in movement patterns (Principal Components, PCs) correlated with changes in the vGRF. The PCA was conducted on the normalized data from all subjects and thus allowed for direct comparisons of movement patterns between subjects. **Results** Despite individual differences, movement variations were overall consistent. PCs 1-3 visualized most clearly the different conditions and characterized larger whole body movements such as wider leg joint angles and elevated spine (high), or a forward position (offensive). The opposite was seen for low and defensive. PCs 4-8 represented different compensatory movements during the sit-to-jump transition, while PCs 9-15 represented mainly arm and head movements. A defensive or low sitting position created lower vGRF peak forces that were more slowly generated, while the opposite was found for offensive and high. **Discussion** Results indicated that athletes largely interpret training instructions similarly, resulting in characteristic variations in sitting posture and jump kinematics. Furthermore, movement patterns and vertical forces are related, although causality cannot be inferred in the present study. Visualization of the PCs can help coaches and athletes to better understand the often ambiguous descriptions of movement patterns and variations. **References** Federolf et al. *Journal of Biomechanics* 46 (2013) 2173-2178 Contact [adnemarl@stud.ntnu.no](mailto:adnemarl@stud.ntnu.no)

### FUNCTIONAL ONE-LEGGED JUMPING HEIGHT IS DETERMINED BY KNEE JOINT POWER AND SWING LEG HIP POWER IN YOUNG FEMALE HANDBALL PLAYERS

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**Introduction** One-legged jumping performance is an important game-changing skill in many ball sports, e.g. handball, and information about the kinematics and kinetics contributing to increased jump height may aid the trainers in designing training regimes. The aim of this study was to investigate which joint power parameters in the take-off leg and the swing-leg, as well as isolated measures of muscle strength and explosive leg power, may be influencing jump height in female handball. **Methods** 27 female handball players aged 16-18 from two top-12 teams in the Danish under-18 volunteered to participate. All subjects were tested for maximal isometric knee extension strength (MVIC) in an isometric dynamometer (Meitür, Finland). The subjects were tested for maximal countermovement jump height (CMJ) and maximal one-legged jump height (OLJ) in a 3D biomechanical laboratory. CMJ height was used as a measure of overall leg extension power. Besides maximal OLJ height, maximal 3D joint moments and - powers for the take-off leg and swing leg hip joint were derived as parameters relevant for jumping performance. Multiple regression analysis was used to identify overall important parameters for OLJ. The kinetic parameters were also compared between the best 9 OLJ performers and the 9 poorest performers using T-tests in order to further elucidate which parameters distinguish good performers from poor performers. **Results** The regression analysis showed

that knee joint power and swing leg hip power were the two most important parameters for OJ performance. The 9 best OJ subjects were significantly superior in knee extensor moment, hip abductor moment, concentric knee joint power, swing leg hip concentric power and swing leg knee concentric hip power. MVIC was not related, while maximal CMJ performance was only weakly related, to OJ performance. Surprisingly, the OJ height was not related to MVIC, and only weakly correlated to total CMJ height. This may imply, that the very dynamic loading of the take-off leg is more related to a task-specific activation, particular of the knee extensors, which is different from isometric MVIC or more symmetric CMJ activation patterns. Furthermore, the increased concentric and eccentric hip joint powers of the swing leg indicates, an importance of a forceful hip flexion of the swing leg followed by a fast breaking of the flexion in the end of the push-off phase, which transfers momentum from the swing leg to the body thus increasing OJ height. Therefore, dynamic power training of the take-off leg and focus on adequate swing leg action may increase OJ height in young female handball players.

## Oral presentations

### OP-SH15 Physical Education & Pedagogics I

#### IN THE CROSSING OF THE FIELDS OF EDUCATION AND SPORT: SOCIAL SELECTION AMONG PUPILS IN SCHOOL SPORTS

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**Introduction** With reference to Bourdieu's theoretical framework, the fields of education and sport can be seen as social fields in which choice and social selection are influenced partly by the possession of capital and habitus and partly by the organisational and structural circumstances. This paper sets out to investigate those pupils who, in the crossing of the fields of education and sports, choose and have been selected to participate in school sports in Sweden. From a cultural sociological perspective, the main purpose of this paper is to identify and analyse how organisational conditions and pupils' social characteristics interact with the different selection processes underlying upper secondary pupils' participation in school sports. **Methods** For the analysis of the selection of pupils on a national level, we use registry data on upper secondary school pupils in Sweden. For the analysis of the selection process on an individual level, data were derived from two questionnaire surveys completed by pupils participating in school sports at 18 strategically selected upper secondary school during 2008 and 2009. In total, the survey data consist of answers from 677 pupils (386 boys and 291 girls). For this paper, the conforming parts of the questionnaires were merged, and include information about the pupils' social background, choice of education, athletic level and parental involvement in sport. Characteristics that can be seen as indications of the possession of an educational capital and sporting capital. Results Swedish school sports are organised primarily in combination with academic study programmes and team sport, and this results in that in comparison the nationwide population pupils who participate in school sports are: to a higher degree boys, attending academic study programs, have Swedish background and whose parents have a higher education level ( $p < 0.05$ ). Furthermore, the result show that the choice between different school sports programmes is related to the pupils' possession of educational capital and sporting capital. School sports programmes with higher demands on athletic ability require larger possessions of capital among the pupils ( $p < 0.05$ ). **Discussion** We argue that school sports, through the crossing of the two fields of education and sports, increase the social selection among the pupil. The organisational condition for school sports makes participation neither reasonable nor possible for all pupils. Instead, the supply of school sport appeals to a narrow or rather specific taste for sport and education. In this sense school sport is generally organized in a way to attract boys with highly educated parents and with an interest in sports. Contact: magnus.ferry@umu.se

#### HEALTH EDUCATION IN HPE TEACHER STUDENTS' BACHELOR/MASTER THESIS

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Research shows that teaching content and power technologies, which rewards certain bodies in the school subject Health and Physical Education (HPE), contribute to inequality. WHO advocates equal health, and states that it is important to improve conditions for peoples' daily life by for instance eliminating the unequal distribution of power, money and resources. Inequality in HPE can therefore be regarded as unhealthy teaching conditions. The research provides no guidance on how teachers should teach pupils who do not experience HPE as positive. The purpose of this study is to investigate how HPE teacher students relate to health in HPE. The study is based on the following questions: - What kind of health-related problems do the students investigate? - What is healthy education in HPE according to teacher students' Bachelor/Master thesis? Health can be part of the teaching content of HPE, but it can also be a part of the didactics, meaning that the ontological and epistemological related decisions in the teaching context can be more or less disciplinizing, regulating and normalizing. The tradition of the German didactics, aligned with epistemological conceptions related to other theories of education, can be of use in this study. Implicit ideological teaching principles can be analyzed using teaching methods and teaching content as empirical material. The research questions demands a qualitative didactical analysis of texts. The study involves 81 thesis, connected to HPE school subject, examined at six different Swedish universities, all of them examined in 2012. The result shows that students are investigating health mainly from two different positions. One is measurements of the body or body performances; either to promote elite sport or public health (like BMI, burnout or fitness results). The theoretical perspectives in these studies are either natural sciences or psychology. When the concern with this perspective is connected to public health, health is understood from a pathogenic horizon. The other position is derived from a described need of learning how to teach health or to teach in a healthy way. It is common that a public health perspective is used to explain why health(y) education is important. HPE is argued to be important especially for those who aren't physically active in their leisure time. The HPE students often search for ways to teach and promote health at an individual level. Here, a salutogenic activity based approach with the individual in center is supported. When the teaching content is activity-based, and when the teacher decides what health promoting activities is, some pupils are rewarded and some are not. HPE education in the interviewed teachers' and the HPE students' context cannot thus be seen as a healthy equality project.



### SWEDISH PE TEACHERS' GRADING PRACTICE IN A STANDARD BASED GRADING SYSTEM

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Instead of following the standard based grading system in use, which is supposed to support equality and accountability, PE teachers sometimes grade according to internalized criteria or 'gut feelings' (Hay & McDonald, 2008; Svennberg, Meckbach & Redelius, 2014). Therefore the validity of the grades has been questioned (Annerstedt & Larsson, 2008). The aim of this study is to explore Swedish PE teachers' grading practice and what they value in the grades given to their students. Four PE teachers in compulsory school were interviewed with the Repertory Grid (RG) technique. The RG technique can be used to reveal a person's perception of a specific topic that the person is familiar with, by examining the similarities and differences between well-known elements (Fransella, Bell & Bannister, 2004). First the teacher was asked to select seven to eight students from a class that he or she was teaching and grading in PE. The students selected must represent all possible grades (Fransella et al., 2004). In the second step, the names of three of the students at the time were presented to the teacher who was asked in what way, relevant for the grades, two of the students were similar and different from the third (Fransella et al., 2004). In the third step, the teachers were asked to rate the students on how they corresponded to the similarities and differences mentioned. The resulting grids were analysed with the programme WEBGRID5. Besides knowledge and skills all four teachers valued standard irrelevant criteria. The standard irrelevant criteria generally also matched the grades given. There were differences in how the national standards matched the given grades. and some national standards were not mentioned at all. It seems like some standards have been better implemented than others. The results indicate the need for a discussion of why standard irrelevant criteria such as motivation and effort seem more relevant for teachers to use than the national grading criteria. Bernsteins' interrelated systems of curriculum, pedagogy and assessment (2003) can contribute to the understanding. It is also important to discuss why some national grading criteria are easier for the teachers to implement than others. References Annerstedt C, Larsson S. (2010). European Physical Education Review, 16(2), 97-115. Bernstein B. (2003). Class, codes and control. (Vol. 3) Towards a theory of educational transmission, Routledge & Kegan Paul, London. Fransella, F., Bell, R. & Bannister, D. (2004). A manual for repertory grid technique. (2nd. ed.). Wiley, Chichester, West Sussex. Hay P, MacDonald D. (2008). Assessment In Education: Principles, Policy & Practice 15(2): 153-168. Svennberg L, Meckbach J, Redelius K. (2014). European Physical Education Review, 20(2), 199-214.

### BRIDGING THE DISCREPANCY? A STUDY OF PETE TEACHER'S PERCEPTIONS OF THE NEW SYLLABUS IN PEH IN SWEDEN.

Ekberg, J.

*Malmö University*

Introduction Physical Education is described as a popular subject, and as being important for both the individual as for the society. Still several studies discuss problems identifying the subject content, in Sweden as in many other countries. For instance, Ekberg (2014) argues, based on a study of physical education and health (PEH) in the prior curriculum in Sweden, that there are discrepancy between the steering documents on the one hand and what teachers says and what occurs in the learning situation on the other hand. The content knowledge of the field of formulation is largely reformulated in the field of transformation, but no major change takes place from the field of transformation to the field of realisation. Ekberg concludes that the prior syllabus for the contemporary school was vague on several points and the relations between sport and health were not made clear. According to the Swedish government, the new curriculum and syllabuses in Sweden, introduced 2011, is supposed to provide better and clearer instructions about objectives, knowledge content and knowledge requirements. The study In the light of this, the aim of the study is to examine if the new syllabus in PEH is perceived to be more consistent than the latter one, and if so, whether and how this might have contributed to bridging the discrepancy between the field of formulation on the one hand and the fields of transformation and realisation on the other hand. This research draws upon curriculum theory and the social construction of knowledge, as inspired by Bernstein, Lundgren and Linde. Interviews are made with experienced physical education teacher education (PETE) teachers in Sweden. The result will contribute with knowledge about the new syllabus for PEH and the perceived consistent and the possible contribution to bridging the discrepancy described. Moreover, the study will offer understanding about what subject content seems to be valid in the subject in Sweden today. References Bernstein, B. 2000. Pedagogy, Symbolic Control and Identity: Theory, Research, Critique (Revised edition). Lanham, Md.: Rowman & Littlefield Publishers. Ekberg, J.E. 2014. What knowledge appears as valid in the subject of Physical Education and Health? A study of the subject on three levels in year 9 in Sweden. Physical Education and Sport Pedagogy. Published online: 26 Aug 2014 Linde, G. 2006. Det ska ni veta!: en introduktion till läroplansteori. Lund: Studentlitteratur. Lundgren, U.P. 1981. Att organisera omvärlden: en introduktion till läroplansteori. Stockholm: Liber Förlag.

### CRITICAL THINKING DISPOSITION OF THE STUDENTS STUDYING SPORT SCIENCE AT UNIVERSITY

Sunay, H.

*Ankara University*

Introduction Individuals' adaption to innovation in social life easily, using acquired rights, developing critical thinking skill have an important place understanding of today's modern education. With contemporary education, it is intended to grow individuals who are versatile, productive, investigating, questioning, skeptical and situations faced new information.(Tural and Secgin 2012). The aim of this research is to examine whether the critical thinking disposition of the students studying at university changes or not according to the variables. Methods In this study, it is tried to determine whether the critical thinking level of sport students at university vary according to the individual variables and so the relevant sources has been scanned. Therefore, organized research screening model has a descriptive study. The universe of the research consists of 2800 university students who participated in the sports contests organized by Ankara University in 2013-2014 academic year and intercollegiate contests. The sample group of this study consists of 203 sport students continuing their education at Ankara university in 2013-2014 academic year are selected by random. California Critical Thinking Disposition Inventory (CCTDI) : This scale emerged as a result of Delphin Project organized by Amerikan Philosophy Association in 1990. Discussions In this study, it is the matter to be considered on low curiosity points of the students who should have the qualities such as learning new techniques, establishing cause and effect relationships for competitions. According to these data, it can be said that critical thinking skills is a mechanism which can change according to the process of vocational education, sports experience, personality characteristics, demographic characteristics of the sample. Therefore, the survey data reveals that critical thinking dispositions have been affected by several variables. Having a tendency to search for the truth ,to be able to evaluate different ideas objectively,accepting the thoughts even

if they conflict with his own ideas are important for an athlete. (Tural and Secgin, 2012). Results As a result, it has been identified that students' critical thinking levels didn't change by sex, but the critical thinking levels of sport students who are studying in other faculties and academies are higher than those who are studying in SPES. Moreover, the critical thinking levels of students involved in 1-3 and 4-6 years were lower than those involved in 7 years and over. References Kokdemir D 2003. Uncertainty situation that decision making and Problem solving, PhD thesis, Ankara University, Institute of Social Sciences; Ankara. Tural A and Secgin F 2012. Social studies teacher candidates' science and technology, with a study on Trends of critical thinking, e-journal of research in international education, 3(1): Winter, 63-77. Contact: [hsunay@ankara.edu.tr](mailto:hsunay@ankara.edu.tr) Do not insert author here

**'WE SHOULD ALSO HAVE A CHANCE TO BE INCLUDED.' DISABILITY, GENDER AND PHYSICAL EDUCATION**

Apelmo, E.

*Faculty of Health and Society*

The aim of this paper was to explore how young, sporting women with physical impairments experience physical education (PE), drawing on research on PE as well as on critical disability studies. Phenomenology (Ahmed 2006; de Beauvoir 1949/2011; Merleau-Ponty 1945/2013) provides a sociological theoretical framework that includes the body. Ten semi-structured interviews were done with women ages 15 to 28, living in Sweden. Most of interviews took about an hour. In order to grasp the experience of disability from the view points of the young women themselves, three participants were asked to keep video diaries: they were lent a camcorder and a tripod for two months. The diaries were between 85 to 110 minutes long. The stigmatization the young women experienced in their everyday life resulted in a polarization between the weak, which was expressed through the expression of belonging as 'we', and the strong individual. The subject position as positive and capable – as a reaction towards the weak, the negative – was one of the few positions that were available to them. With the positive and strong attitude, the consequence was the difficulty, not only to complain but also to express pain or discomfort in one's everyday life. However, as regards the issue of PE, the participants discussed problems dealing with experiences of exclusion, being singled out, and special treatment. It appeared to be difficult for teachers to see these women as the sports interested youths that they were. The young women used different strategies of resistance. While a pair of them did not participate in some of the aspects, another woman had chosen not to participate in PE at all. Refusing to be physically active is, according to Larsson et. al. a common form of resistance among girls (with or without impairments) and is interpreted by teachers as lack of interest (2005: 21-22). An important difference is, however, that in this study the young women were very physically active in their leisure time. One participant made use of a strategy which has the potential for changing the view as regards disabled pupils: she showed her teacher medals she had won in the Swedish national swimming championship, as a way to receive a higher grade. When the women finally described the stigmatization that they had been subjected to, they avoided positioning themselves as victims, by minimizing the seriousness of the situation or by using in the interview the word 'we' instead of 'I', thus describing the incident in collective terms. References Ahmed, S. (2006) *Queer phenomenology*. Durham, London: Duke University Press. de Beauvoir, S. (1949/2011) *The second sex*. New York: Vintage Books. Larsson, H, Fagrell, B, & Redelius, K. (2005) "Kön Idrott Skola", [Idrottsforum.org](http://Idrottsforum.org). Available 15-02-14. Merleau-Ponty, M. (1945/2013) *Phenomenology of Perception*. London: Routledge. Contact [elisabet.apelmo@mah.se](mailto:elisabet.apelmo@mah.se)

**12:00 - 13:15**

**Plenary sessions**

**PS-PL02 FROM THE CRADLE TO THE GRAVE - SPORT AND PHYSICAL ACTIVITY FOR A SUSTAINABLE BODY**

**SPORT AND PHYSICAL ACTIVITY FOR A SUSTAINABLE BODY - PAST, PRESENT AND FUTURE CHALLENGES**

Hedenborg, S.

*Malmö University*

Our perceptions of the physically active human body has an interesting history. It has been influenced by what contemporary scientists have discovered as well as social and cultural discourses. In the 18th century statistical methods were developed in Europe in order to keep track of the population sizes and health. An important outcome were the measures developed in order to decrease infant mortality rates. Over time new ideas on how health was to be preserved and how a nation was secured were developed. Sport and physical activity became important tools for governments wanting to shape the modern citizen. Not all bodies were, however, given the same opportunity. Gender, ethnicity, social class and age were important demarcations. There were, for example, strong voices advocating that the female body was not strong enough for sporting activities. An interesting paradox connected to social class developed as some women were seen as strong and capable of hard physical work (women from the working class, or peasantry) whereas others were seen as weak and dependent. Children and young people were affected too. Training advice when it comes to these groups has changed over time. Today the aging body is in focus. In this lecture a fascinating overview of the ideas of the physical active human body will be presented from past to present.

**THE OLDER MUSCLE: AGEING OR DISUSE?**

Harridge, S.

*King's College London*

The prime role of muscle is to act as a biological machine - to produce force and generate power. This is to fulfil a number of different functions from maintaining posture to allowing the performance of all the physical tasks needed for everyday living. But, muscle also has a plethora of other roles which include protein being an important dynamic store, being the largest sink for the storage of glucose and acting as a source of protective padding. As we get older there is an observable reduction in many of these functions. This is primarily related to a loss of tissue mass, which when passing a given threshold is referred to as "sarcopenia". Sarcopenia is associated with an increased risk of falls and sustaining fractures and is an increased risk factor for morbidity and mortality. However, the extent to which sarcopenia and its attendant side effects can be attributed to an inherent biological ageing process are far from clear. At any age muscle

mass and function are acutely sensitive to activity pattern and usage – being highly responsive to both mechanical and metabolic signals. For example, limb immobilisation, bed rest or exposure to microgravity (space flight) all result in muscle loss and weakness- irrespective of age. The effects of many years of a sedentary lifestyle thus seriously confound our understanding of the properties of a muscle we might expect for a given chronological age. For a typical sedentary older person, a smaller muscle seems to relate to both a reduced number of muscle fibres (and motor units) and a selective atrophy of the fast-contracting type II muscle fibres. Muscle “quality” also declines in older sedentary individuals with evidence of fat deposits and connective tissue accumulation. This makes “contractile” tissue mass harder to determine and contributes to the decrease in force potential per unit area (specific force) of a whole muscle in vivo. Furthermore, when rates of muscle protein synthesis are measured using tracer techniques there is evidence of a reduced sensitivity to both exercise and amino acid feeding. What is the cause of the decline in mass and function? To what extent are these phenomena attributable to the biological ageing process and what can be done to ameliorate these deleterious effects? These are some of the key questions that need to be addressed in the light of the dramatic changes in population demographics. Recent experiments on highly active older people have thrown some light on answering these questions. These studies have shown that despite ageing, muscle mass, function and quality can all be well maintained. These data suggest that we need to rethink our perceptions on the interactions between ageing, exercise and physiological function.

## 14:00 - 15:00

### Mini-Orals

#### MO-PM13 Health & Fitness: Lifestyle

##### IS STEPS PER DAY AN ADEQUATE ALTERNATIVE INDICATOR FOR ACHIEVING A TARGET LEVEL OF MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY IN YOUNG ADULT WOMEN?

Kumahara, H.1, Ayabe, M.2

1:Nakamura Gakuen University (Fukuoka, Japan), 2.Okayama Prefectural University (Soja, Japan)

**Introduction** A physically active lifestyle has numerous health benefits. Therefore, several consensus statements have recommended engaging in regular physical activity (PA) with a certain exercise intensity, such as moderate-to-vigorous PA (MVPA), to improve health outcomes. Steps per day (ST) has remained a popular method for evaluating PA recommendations. Several cross-sectional studies have found a correlation between the duration or volume of MVPA (i.e., METs×h) and ST. However, information on the causes of individual variations in the relationships remains scarce. The purpose of the present study was to explore the association between ST and duration of MVPA under free-living conditions. **Methods** Seventy healthy young adult Japanese women (age range 20-29 years) measured their free-living PA using a validated accelerometer for 7 days. **Results** The average ST, MVPA and METs×h were 9297±2705 steps/d, 33.1±14.6 min/d, and 16.6±7.4 METs×h/wk, respectively. Significant correlations were found between ST and MVPA duration and ST and METs×h/wk ( $r=0.81$  and  $r=0.81$ ). ST equivalent to 30 min/d of PA was estimated at 8839 steps/d; however, approximately 1600 steps/d of the standard error of estimates in the regression equations were calculated. A negative correlation was found between individual estimated ST corresponding to 30 min of MVPA and the percentage of MVPA duration of the total daily PA ( $r=-0.67$ ). **Discussion** The findings indicate that the association between ST and MVPA fluctuates depending on individual daily MVPA. Consideration of both the ST and the duration of daily MVPA are necessary to meet PA guidelines and to consequently gain health benefits. The effects of increasing the PA using various PA indicators on several health outcomes will need to be investigated in future studies. Contact kumahara@nakamura-u.ac.jp

##### INFLUENCE OF DOG WALKING ON THE PHYSICAL ACTIVITIES AND LIFE CHANGES OF OWNERS

Furumoto, K.1, Murao, N.1, Onodera, S.2

1 Kurashiki University of Science and The Arts, 2 Kawasaki University of Medical Welfare

**Introduction** Dog walking is a joint physical activity of owner and dog. In comparing non-dog pet owners and non-pet owners with dog owners in Japan, have been reported as more likely to engage in physical activities and walking (Hayakawa, 2008; Oka, 2009; Shibata, 2012). Dog walking has been reported to give a positive influence on the daily life of the dog owner, but there is no detailed report on the relevance of the changes in the dog owner's life and the frequency of dog walking. The objective of this study was to investigate the influence dog walking has on physical activity and the life of the dog owner. **Methods** Dog owners were selected at random and voluntarily participated in this study. The questionnaire contained question items on basic attributes (gender, age), frequency of dog walking, life changes resulting from dog keeping (opportunities for communication with others, amount of exercise, life rhythm, opportunities to go outdoors). **Results and Discussion** The data sample consisted of 347 respondents. 78.4% of owners walked with their dogs. They walked with their dogs 7.3±4.5 (times/week) and the time of dog walking was 41.1±29.2 (minutes/day). These dog owners felt an increase in opportunities for communication with others, an increase in the amount of exercise and they also felt that their over-all life became more well-regulated. These results were always better for dog owners who walked their dogs more often and for longer periods of time. This influence is different by gender, male dog owners obtained more positive influences from walking their dogs than female. In our previous research, male pet owners who had proactively been involved with their pet had better mental health scores. Using the dog walking as a tool for increasing the amount of physical activity, males might effectively.

##### CIRCADIAN RHYTHM OF ACTIVITY LEVELS: INFLUENCE OF CHRONOTYPE.

Bruno, E.1, Roveda, E.1, Vitale, J.A.1, Montaruli, A.1, Caumo, A.1,2, Carandente, F.1

1. UNIMI, Milan, Italy; 2. IRCCS Policlinico San Donato Milanese, Milano, Italy.

**Aim:** The aim of this study is to investigate, by an actigraph monitoring, the differences in the circadian rhythm of activity level in relation to the chronotype for the sake of studying its influence on physical performance. Morning-type (M-type), Evening-type (E-types) and Neither-

type (N-type) are the classified chronotypes; several studies showed the differences between M-types and E-types in the circadian rhythm of different physiological variables: M-types use to wake up and go to bed early and to have their best performances in the first part of the day, otherwise E-types go to bed and wake up late and they have the peak performances in the evening (Vitale et al., 2013). Method: The morningness-eveningness questionnaire (MEQ) was administered to 502 college students to determine their chronotypes. Fifty subjects (16 M-types, 15 N-types and 19 E-types) were recruited to undergo a 7-days monitoring period with an actigraph (Actiwach actometers, CNT, Cambridge, UK) to evaluate their sleep parameters and the circadian rhythm of their activity levels. To evaluate the circadian rhythmicity of activity levels we used the single cosinor method (Halberg et al., 1977) and we define three parameters characteristic of each statistically significant rhythm: M, MESOR (Midline Estimating Statistic Of Rhythm); A, Amplitude;  $\phi$ , acrophase. The population circadian characteristics were determined and then compared using the Hotelling test. Results: Rhythmometric analysis, with the single cosinor method, on the activity data collected by the actigraph revealed a statistically significant circadian rhythm ( $p < 0.001$ ) for all the 50 subjects. The population mean cosinors were calculated grouping the different chronotypes: M-types, E-types and N-types ( $p < 0.001$ ). No statistical differences about MESOR were showed for all group combinations ( $p > 0.05$ ) but a significant difference ( $p < 0.05$ ) was observed if considering the Amplitude-Acrophase test for all groups combinations, in particular M-types had an early acrophase of the circadian rhythm of the activity levels, at 14.37, while E-types showed an acrophase with more than 2 hours late, at 17.04 ( $p < 0.001$ ); the group of N-types showed an intermediate acrophase, at 15.45, between morning-types and evening-types. Conclusion: We can assume that there is a clear difference between "larks" and "owls" and this results are in line with other studies that showed the biological differences among chronotypes. We can conclude that M-types are more active in the early afternoon and that E-types have the peak of their activity in the late afternoon. Further studies are needed to better understand if and how the chronotype influence a physical performance. References 1. Halberg F., Carandente F., Cornelissen G., Katinas G.S. (1977). Glossary of chronobiology. *Chronobiologia* 4 (Suppl. 1):1-189. 2. Vitale J.A., Calogiuri G., Weydahl A. (2013). *Percept. Mot. Skills.* 116(3):1020-1028.

### PHYSICAL FITNESS OF MIDDLE-AGED WOMEN: EFFECTS OF SYSTEMATIZED EXERCISE

Silvatti, A., Caldas, L., Rodrigues, M., Rodrigues, I., Bernardina, G., Andrade, A., Hamill, J.

*Universidade Federal de Viçosa*

**Introduction** Since the practice of physical exercises contributes significantly to the maintenance of physical fitness, the objective of this study was to investigate the effects of an annual periodization on physical fitness of middle-aged women. **Methods** 27 physically active middle-aged women (+/-52 years) performed a systematic physical activity program (3 times a week, 50 min/session). The annual periodization (1) was divided in 3 blocks (8 to 12 weeks each): 1st Block - cardiorespiratory function; 2nd Block - flexibility, coordination and balance; and 3rd Block - strength. We evaluated their physical capacity three times: pre-testing (T1); at the end of the 2nd (T2); and the 3rd block (T3) (VO2max-1600m walk test, bank of wells test, sock test, get up from the floor test, Agility/Dynamic balance, Sitting-Rising test and Abdominal) [2,3]. We verified the normality and sphericity of the data (Shapiro-Wilk and Mauchly's) and applied the ANOVA test with repeated measures ( $p < 0.05$ ) to analyze the effectiveness of the training. Since, the tests related to the evaluation of strength capacity were not performed after the 2nd block we used a paired t-test ( $p < 0.05$ ). **Results** The mean values of the VO2max and flexibility significantly increased in T2 compared to T1 and these values were maintained after the strength block. The mean value of BMI significantly decreased between T3 compared to T2. An improvement in the mean value of the sock test was found in the T2 and, in T3, we found a significant decrease of these values compare with T1 and T2. Both tests performed to evaluate strength showed a significant improvement in T3 compare with T1. **Discussion** Our results agree with the literature and highlight that systematized exercise increase physical fitness. Since we found a gain in the strength, flexibility and coordination capacity we can assume that these women improved their autonomy in the Activities of Daily Living. No significant difference was found in the others tests; however, just a preservation of their capacities is significant since there is a general decline in these measures with the aging. Therefore, we conclude that our annual periodization for middle-aged women was effective in improving or maintaining their cardiorespiratory function, flexibility, coordination and strength. **References** (1) American College of Sports Medicine www.acsm.org (2) Clark BA. Tests for fitness in older adults: AAHPERD fitness task force. *JOPERD.* 1989; 60: 66-71 (3) Osness WH, et al. Functional fitness assessment for adults over 60 years (A field based assessment): Published test protocols. AAHPERD. Reston, VA, U.S.A 1990; 1-24 **Acknowledgments:** FAPEMIG, CAPES, CNPQ, Prefeitura Municipal de Viçosa Contact amandasilvatti@ufv.br

### GENETIC AND ENVIRONMENTAL INFLUENCES ON MOTIVES FOR LEISURE-TIME PHYSICAL ACTIVITY BEHAVIOR

Aaltonen, S.1, Kujala, U.M.2, Kaprio, J.1,3, Silventoinen, K.1

*University of Helsinki*

(1) University of Helsinki (Helsinki, Finland) (2) University of Jyväskylä (Jyväskylä, Finland) (3) National Institute for Health and Welfare (Helsinki, Finland) **Introduction** Twin and family studies indicate that physical activity is affected by genetic factors. Also motives for physical activity have been revealed to be important for physical activity behavior. To unite these findings raises a question whether the motives for physical activity can be heritable themselves. A few existing studies have suggested that genetic factors may influence person's motivation to engage in physical activity. The aim of the study was to examine whether genetic and environmental influences act as potential factors explaining the motives for engaging in leisure-time physical activity. **Methods** The participants were identified from the FinnTwin16 study (Finnish twins born between 1974 and 1979) and surveyed with questionnaire at the mean age of 34.1 years. Altogether, 2 972 twins were included in the quantitative genetic analyses. Since a pregnancy can prevent engagement in leisure-time physical activity, twins who were pregnant were excluded. The motives for leisure-time physical activity were assessed using the validated Recreational Exercise Motivation Measure (REMM) consisting eight dimensions (mastery, physical fitness, affiliation, psychological state, appearance, others' expectations, enjoyment, competition/ego). Quantitative genetic models were performed with the OpenMx software. **Results** Among the twins, physical fitness was the most frequently reported motivation dimension, followed by the psychological state. The highest genetic contribution was found to be for the enjoyment motive component in women (52%) and for the mastery motive component in men (28%). Next in order of genetic contribution were the dimensions: enjoyment (27%), affiliation (24%), psychological state (23%) and appearance (23%) in men and appearance (27%), mastery (25%) and affiliation (22%) in women. The lowest genetic contribution was found for the others' expectations both in men (14%) and women (8%). The remaining variances were explained by specific environmental influences, except physical fitness, appearance, enjoyment and competition in men, psychological state and others' expectations in women and affiliation in men and women. Shared environmental factors had a small contribution to those motive dimensions. **Discussion** It is concluded that the enjoyment was heritable motive for leisure-time physical activity behavior in women. The enjoyment was less heritable in men than in women, but still moderate in magnitude. The motives related to appearance, skill improvement and the social aspects of

physical activity were moderately heritable both in men and women. However, specific environmental influences seem to be crucial in explaining motive dimensions. Contact sari.s.aaltonen@helsinki.fi

### HIGH MATERNAL PHYSICAL ACTIVITY DURING LATE PREGNANCY IS ASSOCIATED WITH HIGHER SERUM CONCENTRATIONS OF BDNF IN CORD BLOOD

Ferrari, N.1, Merz, W.M.2, Floeck, A.2, Brockmeier, K.3, Strueder, H.K.4, Graf, C.4

1:UK Cologne, Cologne Centre for Prevention in Childhood & Youth (GER), 2:UK Bonn, Medical School (GER), 3:UK Cologne, Heart Center (GER), 4:DSHS Institute of Movement & Neuroscience (GER)

**Introduction** Physical activity during pregnancy has several positive effects on maternal metabolism and fetal/neonatal development. However the precise mechanisms underlying these effects are largely unknown. Leptin, resistin and brain-derived neurotrophic factor (BDNF) are involved in metabolism and brain development and may thus play a role in the manifestation of these beneficial effects and their transmission to the fetus/neonate. **Methods** A prospective cross-sectional cohort study was conducted between December 2013 and April 2014 at the Cologne Sports University and the University Bonn Medical School, Germany. 112 women who were admitted for delivery, with a singleton pregnancy and gestational age between 36 and 42 weeks were included. Physical activity during late pregnancy (third trimester) was assessed by the Pregnancy Physical Activity Questionnaire (PPAQ). To calculate the average daily total energy expenditure, activity was classified by intensity in METs and divided in tertiles: inactive, moderately or vigorously active. Maternal and cord blood serum levels of BDNF were investigated by a multiplex immunoassay (eBioscience, Frankfurt/Germany). Samples were run in duplicate. **Results** Women who were moderately active during late pregnancy tended to have higher maternal BDNF levels compared to inactive women (986.1+/-566.6 pg/ml vs. 738.6+/-480.6 pg/ml;  $p=0.061$ ). In addition, neonates from mothers who were vigorously active during late pregnancy had higher cord blood levels of BDNF compared to neonates from inactive mothers (766.1+/-454.3 pg/ml vs. 579.7+/-303.3 pg/ml;  $p=0.057$ ). There were no effects of physical activity during late pregnancy on neonatal leptin and resistin levels (data not shown). **Discussion** Within this prospective cross-sectional study higher BDNF levels were present in neonates from mothers who had been active during late pregnancy. No association was found for leptin and resistin. To clarify the mechanisms underlying the observed health benefits further prospective and controlled studies are warranted. Contact n.ferrari@dshs-koeln.de

### WHY DO PEOPLE EXERCISE IN NATURE? DIFFERENTIATING ADULT NORWEGIAN'S BELIEFS ABOUT PARTICIPATING IN GREEN EXERCISE, FITNESS AND SPORTS

Calogiuri, G.

Hedmark University College

**Introduction** Understanding beliefs related to physical activity (PA) is a key issue in PA promotion. Different forms of PA are characterized by different motivations, e.g. fitness activities are associated with body- and health-related expectations, while sport participation is associated with enjoyment and interest (Kilpatrick et al., 2005). To date little is known about motivation for green exercise (GE), which is any PA in contact with nature. The aim of this study was to identify PA-related beliefs associated with participation in GE as compared to sport and fitness. **Methods** The data were derived from a survey initiated by Friluftslivets Fellesorganisasjon ([www.frifo.no](http://www.frifo.no)). Stratified-randomized sampling was used to recruit 2168 adult Norwegians (51+/-15 years; 49.6% females). Participants reported socio-demographic information, PA behaviors, and importance given to different factors related to PA participation. Principal component analysis was used to identify the main groups of beliefs. Multinomial logistic analysis was used to assess the likelihood (OR [95%CI]) of participating in each form of PA for 60-149 min/week or 150+ min/week, controlling for socio-demographic variables. **Results** 'Affective beliefs' predicted participation in GE at both cut-off (1.52 [1.22-1.91] and 3.83 [2.87-5.10]). Moreover, those who engaged in GE for 150+ min/week were more likely to assign greater importance to 'Convenience' (1.89 [1.44-2.48]) and less to 'Instrumental beliefs' (0.63 [0.48-0.83]). On the other hand, 'Affective beliefs' predicted participation in sport and fitness only when the higher cut-off was applied (sport= 3.54 [2.04-6.15]; fitness= 2.04 [1.42-2.92]). Sport participation was associated with 'Sociability' at both cut-off (2.09 [1.62-2.70] and 2.34 [1.59-3.43]), while fitness was associated with 'Instrumental beliefs' (2.60 [1.88-3.59] and 3.11 [2.10-4.59]), and both sport and fitness were negatively associated with 'Convenience' (sport= 0.39 [0.29-0.54] and 0.30 [0.19-0.48]; fitness= 0.51 [0.39-0.68] and 0.38 [0.27-0.53]). **Discussion** Green exercisers assign greater importance to affective aspects of PA such as enjoyment and feeling good. Furthermore, people who assign greater importance to convenience are more likely to engage in GE and less likely to participate in sport and fitness. The vitalizing effects of exposure to nature (Ryan et al., 2010) and the fact that people can exercise in green spaces for free, whenever it suits them and with no pressure from others, can be important motivational factors for GE and lead to greater adherence to PA. **References** Kilpatrick M, Hebert E, Bartholomew J (2005). *J Am Coll Health*, 54(2), 87-94 Ryan RM, Weinstein N, Bernstein J, Brown KW, Mistretta L, Gagne M (2010). *J Environ Psych* 30(2), 159-168

### THE RELATIONSHIP BETWEEN HABITS OF DAILY EXERCISE AND THE TENDENCY OF SPIRITUALITY.

Nigorikawa, T.1, Mitsuishi, H.2

(1)Rikkyo University (2)Kyoto Gakuen University

**Introduction** Many previous studies have shown that there should be strong relations between the human's quality of life (QOL) and spirituality. Therefore, it was considered that human's health and spirituality have close relations. There are also many studies that referred the relationships between habits of daily exercise and psychological factors. However, there is hardly any study that mentioned the relations between the habits of daily exercise and the tendency of spirituality which this study tried to investigate. **Methods** The subjects of the study consisted of 220 male and 333 female university students. They were divided into two groups: the Exercise Group (n=218) and the Non-exercise Group (n=335). The Exercise Group consisted of students who habitually performed 30 minutes or more of exercise more than twice a week. The Non-exercise Group was made up of students who undertook less exercise than this. The tendency toward spirituality was measured using The Japanese Youth Spirituality Rating Scale (JYS), The Purpose In Life Test (PIL) and The Views of Life and Death Scale (VLD). **Results** The exercise group showed higher scores of JYS and PIL than those of the non-exercise group. However, there was no significant difference in VLD. This means that the exercise group has stronger tendency of spirituality than the non-exercise group. There was almost no difference in the results between male and female. **Discussion** Our previous study suggested that there was a relationship between habits of daily exercise and the tendency of spirituality. In this study the same investigation was made using different subjects and indicators which estimate one's spiritual tendency. Almost the same results as in the previous research were obtained. Further investigation is demanded to clear what kind of mechanisms lead to this result.

## SOCIO-DEMOGRAPHIC AND PSYCHOLOGICAL VARIABLES INFLUENCING THE APPLICATION OF PHYSICAL ACTIVITY AS A GENERAL RESISTANCE RESOURCE

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Introduction: Aaron Antonovsky's Salutogenic model of health emphasizes the idea of General Resistance Resources (GRRs) – factors that help to reach a Sense of Coherence in our life. Antonovsky's thoughts inspired the Health Promotion Research Group of Szeged, Hungary, to survey the spectrum of resources that can be mobilized in difficult life situations. On the one hand we have analysed the relative position of Physical Activity as a GRR compared to other resistance resources. On the other hand we have studied the way socio-demographic situation and defining factors of psychological life quality affect the chance of applying physical activity as a coping strategy. Methods: A structured assisted questionnaire interview was performed on a large socio-demographically representative sample (N=1839) from among the population of Hódmezővásárhely County town (Hungary). The questionnaire enquired about the mental health status and the GRRs of respondents, from which we will focus on the latter one. Data were processed with the help of SPSS 15.0. Results: Analysing the relative position of physical activity as a GRR has revealed its multiply undervalued role compared to other researched GRRs. The subjective value of this GRR is average: 9th position out of the list of 18 items. When studying factors influencing lifespan, only 1,1% of respondents contributed decisive importance to the lack of physical activity. We have analysed with the help of logistic regression analysis the effect of several socio-demographic (sex, age, level of education, marital status and financial status) and psychological (subjective well-being, depression, hopelessness, vital exhaustion, general self-efficacy, life meaning) independent variables influencing the chance of applying physical activity as a coping method. The logistic regression model we used proved to be significant ( $\chi^2 = 256.315$ ,  $df = 12$ ,  $N = 1839$ ,  $p < .001$ ). On the basis of our model it can be stated, that three socio-demographic variables (age:  $OR = .980$ ,  $p < .001$ , level of education:  $OR = 1.570$ ,  $p < .001$ , marital status:  $OR = 1.628$ ,  $p < .001$ ) and two variables measuring psychological life quality (subjective well-being  $OR = 1.132$ ,  $p < .001$ ; and life meaning  $OR = 1.078$ ,  $p < .007$ ) influenced significantly the odds of physical activity's acting as a coping method. Discussion: Our results could gain importance in designing health promoting programmes making Hungarian population aware of the role of physical activity as a General Resistance Resource. References: Antonovsky A. (1979). Health, stress and coping. San Francisco: Jossey-Bass. Lindström, B. & Eriksson, M. (2006). Contextualizing salutogenesis and Antonovsky in public health development. *Health Promotion International*, 21(3), pp. 238-244. Kopp, M., & Kovács, M.E. (szerk., 2006). A magyar népesség életminősége az ezredfordulón. Budapest: Semmelweis Kiadó

## Mini-Orals

### MO-PM15 Health & Fitness: Mixed session

#### CHARACTERISTICS OF RUNNERS WALKING AND/OR STOPPING IN THE SECOND HALF OF MARATHON RACES

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Introduction City marathoners often walk and/or stop after 30 km. In city marathon races, faster runners tend to run continuously until reaching the finish line, whereas slower runners typically walk and/or stop before finishing. The factors influencing the differences in these types of runners are unclear. This study aimed to determine the characteristics of runners who walked and/or stopped in the second half of marathon races. Methods This study was undertaken at two popular city marathons held in Japan: the 34th Tsukuba Marathon and the 21st Senu International City Marathon. A total of 205 male runners (mean age,  $41 \pm 10$  years; height,  $171 \pm 6$  cm; weight,  $63 \pm 7$  kg; finish time,  $3:40:35 \pm 0:42:24$ ) who completed each race were surveyed. The survey questionnaire included queries on the finish time, number card, age, body mass index (BMI), training volume (monthly running distance), exertion to the point of breathlessness and leg fatigue indexes for each 5 km interval from the start line, and whether the respondents walked and/or stopped (not dropped out) during the race. The lap time for each 5 km was recorded from the respondent runners' number cards. Results Walking and/or stopping runners (WSR) totaled 71 and continuous running runners (CRR) totaled 134. The mean race completion time of WSR was significantly slower than that of CRR (4:04:08 vs. 3:28:07). In addition, WSR were younger (39 yrs vs 42 yrs), ran shorter monthly distances (159 km vs 213 km), and had higher BMI (22.1 vs 21.0) than CRR. The exertion to breathlessness indexes for each 5 km did not differ significantly between the groups; however, exertion to leg fatigue indexes (measured between 20 and 40 km), and the decreasing rate for each 5 km lap from 20 km onwards, were greater in WSR than CRR. Discussion This study was consistent with previous research in establishing that the finish time of marathon races was associated with large training volume (Bale et al., 1985; Sjodin et al., 1985). However, previous studies did not consider whether the marathoners were running continuously or walking and/or stopping during the races. In this study, WSR had a slower finish time and shorter monthly running distances than CRR. In addition, exertion to leg fatigue indexes and the decreasing rate for each 5 km lap from 20 km onwards were greater in the WSR than the CRR. Smaller training volume therefore results in much more leg fatigue after 20 km, and reduction in running pace occurs at around the same time. Ultimately, the incremental leg fatigue and reduction in pace induce walking and/or stopping during the races, and result in a slower finish time. Reference Bale P., Rowell S., Colley E. (1985). *J Sports Sci.*, 3, 115-126. Sjodin B., Svedenhag J. (1985). *Sports Med.*, 2, 83-99.

#### 'SLOW WALKING & TURN' TRAINING FOR HEALTH PROMOTION OF THE ELDERLY.

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Introduction Decline of physical functions and activities in daily life in the late elderly, results in long, but unhealthy life that requires some professional care. Principal reason of the long, unhealthy life is aging of the skeletal muscles. Loss of muscle mass and weakness, leads to serious health problems such as lowering of muscle strength and aerobic capacity. It is important for the elderly to start exercising as soon as possible in order to improve physical functions. Light intensity training, such as walking is not effective enough, thus exercise for muscle strength, muscle mass and aerobic capacity improvements should be of moderate intensity. We examined a new exercise pattern: 'Slow Walking & Turn (SWT)' that incorporates turns as an extra load to walking. Subjects and Methods Subjects performed SWT and treadmill walking (TW) in random order. In SWT, subject walked back and forth on a fixed distance with 20 turns per minute. We exam-

ined SWT on a distance of 1.5, 2.0 and 2.5m, at walking pace of 180bpm, 6 steps per straight-line walking and 3 steps per turning. TW speed was set at 2.7, 3.6 and 4.5km/h, adapted to straight walking speed of SWT. Subjects of Study 1 were 8 healthy persons from 22 years old to 37 years old. In order to assure the correct exercise intensity and safety, we measured the oxygen uptake, Rating of Perceived Exertion (RPE) and heart rate during each exercise. Subjects of Study 2 were 6 healthy males. We selected 11 muscles of trunk and lower limbs and measured EMG in SWT and TW in order to compare the muscle activity of the stance phase in turn and TW. In addition, we measured the EMG of isometric maximum muscle strength. The muscle activity of SWT and TW were normalized in order to evaluate muscle activity level. Muscle activity level of turn was averaged five times for SWT and 5 steps were averaged for TW. We used the foot sensor for time measurements. Result In Study 1, metabolic equivalent of SWT was significantly High. At SWT distance of 1.5, 2.0 and 2.5m, metabolic equivalent was 4.0, 4.4, 4.8 (METs) respectively, while at TW velocity of 2.7, 3.6 and 4.5km/h, metabolic equivalent was 2.6, 3.0, 3.5 (METs), respectively. Moreover, according to the relationship of exercise intensity and HR, rise of heart rate due to incorporating of the turn was not observed. In Study 2, muscle activity level was significantly increased in the muscles of Vastus Medialis, Vastus Lateralis and Erector spinae in turns of SWT rather than TW. Discussion Adding turns to walking increased the energy consumption of SWT even at low-speed. SWT supplies moderate intensity in order to improve muscle strength, muscle mass and aerobic capacity for elderly people who cannot walk fast. Furthermore muscle activity level significantly increased in the muscles of Vastus Medialis, Vastus Lateralis and Erector spinae during turns of SWT compared to TW. Thus the results suggest the possibility of muscle strengthening or muscle mass increase with SWT exercise.

### **PACER AEROBIC FITNESS NORMS FOR KASETSART UNIVERSITY STUDENTS**

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The purpose of this study aimed to construct the aerobic fitness norms for healthy Kasetsart University (KU) students' healthy by using the PACER test. The subjects consisted of 3,929 (1,310 male and 2,301 female) KU students whose ages ranged between 18-22 years. The subjects selected using purposive sampling technique from students who registered in general education course in the second semester, 2013. The PACER test was used to assess cardiorespiratory or aerobic fitness following standardized procedures. Data was analyzed using descriptive statistics of mean, standard deviation and raw score. Aerobic fitness norm was divided into 3 levels; excellence, good and poor. The study results found that the means of the PACER test scores of participants significantly differed between sexes ( $p < 0.05$ ), while ages scores was no significant different. This study constructed an aerobic fitness normative data according to age and gender that using the PACER test for healthy KU students. In general, male students had better cardiorespiratory endurance than female students. However, the aerobic fitness norms for KU students were very low compare to the PACER norm of the Cooper Institute. Therefore, the institute should promote more physical activity and exercise for KU students to develop their cardiorespiratory endurance system or aerobic fitness in the future.

### **THE RELATIONSHIP BETWEEN INTRAMYOCYLLULAR OR EXTRAMYOCYLLULAR LIPID CONTENTS AND CARDIOVASCULAR DISEASE RISKS IN DIFFERENT CARDIORESPIRATORY FITNESS LEVELS**

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BACKGROUND: Ectopic fat accumulation rather than whole-body fat content may be important for predicting cardiovascular disease (CVD) (Lim S et al., 2013). Visceral, subcutaneous, epicardial and hepatic fat accumulations are associated with CVD risks. Additionally, Lipid depots in muscle are located either in interstitial adipose tissue (extramyocellular lipid: EMCL) or in lipid droplets within muscle cells (intramyocellular lipid: IMCL). Habitual exercise brings higher cardiorespiratory fitness, and results in the amelioration of CVD risks with reduction of fat accumulation. However, the relationship between IMCL and EMCL and CVD risks contents in different cardiorespiratory fitness levels remain unclear. PURPOSE: This study aimed to clarify whether IMCL and EMCL contents affect CVD risks in each gender or cardiorespiratory fitness level with a cross-sectional study. METHODS: One-hundred seventy four healthy young, middle-aged and older subjects (18-79 years) were enrolled in this study. The study subjects were divided into 2 groups according to fitness level (high-fitness: HF and low-fitness: LF groups). These groups were divided based on the median value of  $VO_{2max}$  in each sex and decade. IMCL and EMCL contents of the right vastus lateralis muscle were evaluated by  $^1H$ -magnetic resonance spectroscopy. Blood pressure and serum lipids profile were measured as an index of CVD risk. RESULTS: In all subjects, IMCL content was negatively correlated with systolic and diastolic blood pressures (SBP;  $r = -0.21$ ,  $p < 0.01$ , DBP;  $r = -0.18$ ,  $p < 0.05$ ) and total cholesterol level ( $r = -0.20$ ,  $p < 0.01$ ), whereas EMCL content was positively correlated with SBP ( $r = 0.33$ ,  $p < 0.01$ ), DBP ( $r = 0.38$ ,  $p < 0.01$ ), triglycerides ( $r = 0.29$ ,  $p < 0.01$ ) and total cholesterol ( $r = 0.39$ ,  $p < 0.01$ ) levels. As a comparison between fitness levels, significant positive correlation was observed between the EMCL content and total cholesterol level and DBP in the both groups (respectively,  $p < 0.01$ ). IMCL content negatively correlated with the SBP and DBP in the LF group (respectively,  $p < 0.05$ ), but no correlation was seen in HF group. CONCLUSION: These results suggest that EMCL content may be associated with CVD risk without concerning cardiorespiratory fitness levels, while the IMCL content may not be a risk factor of CVD.

### **THE CHARACTERISTICS OF PHYSIQUE AND PHYSICAL FITNESS BETWEEN SOUTH KOREA ELITE NATIONAL TRACK & FIELD MAN PLAYERS**

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The characteristics of physique and physical fitness between South Korea Elite National track & field man players Sung, Bong-ju. 1, Ko, Byoung-goo. 1, 1: Korea Institute of Sport Science(Seoul, Korea) Introduction Korea high school sprinters are superior to the other type athlete in power and muscular endurance, Middle-long distance runners are superior to the other type athlete in cardiovascular endurance and muscular endurance, jumpers are superior to the other type athlete in muscular strength, agility, power and balance. Throwers are superior to the other type athlete in muscular strength, agility and power(kim, M., et al., 2000). Meanwhile, south korea national track-field's fitness research is rare. Therefore, the aim of this study was to evaluate the physical characteristics of the south korea national track & field team each event. Methods These subjects were divided into 4 groups(Sprinter, middle and long distance, jumper, Thrower). We want to know about physique and fitness difference between groups. These items consist of physique(height, weight, %body fat), muscular endurance(push-up, sit-up), muscular strength(grip), flexibility(sit- and reach), agility(side-step),power(vertical jump), cardiovascular endurance( $VO_{2max}$ , % $ATVO_{2max}$ , exercise time). The materials from all the measuring items were testified in one way ANOVA

analysis. Results The thrower group showed significantly better result in weight, muscular strength(grip power) and % body fat than the sprinter group, middle and long distance runner group and the jumper group. The middle-long distance runner group showed significantly better result in VO2max and ATVO2max than other group. The sprinter group showed significantly better result in power(vertical jump) than other group. In conclusion, South Korea national middle-long distance runners(VO2max: 72.6ml/kg/min, ATVO2max: 54ml/kg/min) more superior to the other three groups in cardiovascular endurance. Sprinter's group(vertical jump: 63.1cm) were superior to the other three groups in power. Moreover, thrower group(weight : 97kg, grasping power: 81kg) were superior to the other three groups in muscular strength and more heavier than them. Discussion The south korea elite high school throwing players have the most influence on the muscular strength(kim, M.H., et el, 2000), middle-long distance runner have the most influence on the Cardiovascular endurance and muscular endurance(kim, M.H., et el, 2000), In conclusion, south korea elite track and field players have had adequate physical characteristics. To become a global players will try to reach the first excellent fitness level. References Kim, M.H., Choi, M.D., Lee, M.M and Park, S.H.(2000). Relation of physique and physical fitness to athlete performance in track and field athlete's boy's high school. *Journal of Physical Growth and Motor Development*, 8(2)69-78. Macdougall, J.D.(1977). The anaerobic threshold its significance for the endurance athletes. *Can. J. Appl.sports Science*. 2. 137-140. Contact [bonjournsung@gmail.com](mailto:bonjournsung@gmail.com)

### PELVIC FLOOR EXERCISE TECHNIQUE AFTER SIX WEEKS OF TRAINING AMONG HEALTHY PREGNANT WOMEN – A RANDOMIZED CONTROLLED TRIAL

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Introduction: Pregnant women are advised to exercise pelvic floor muscles regularly. The effectiveness of exercises is determined through the correct technique of their execution. The main aim of the study was to examine the pelvic floor exercise technique among pregnant women before and after six weeks of intervention. Methods: Participants were 42 healthy nulliparas (age  $29 \pm 3$  y, mean  $\pm$  SD) in the second trimester of normal pregnancy. The intervention group (n=27) received one EMG biofeedback session and performed the pelvic floor exercises three times a week with an instructor. The controls (n=15) were neither instructed about nor discouraged from performing pelvic floor exercises. We tested all subjects for pelvic floor exercise technique before and after six weeks of intervention using the Noraxon sEMG and sensors system (Scottsdale, AZ) with vaginal probes for the pelvic floor muscles and the surface electrodes for selected synergistic muscles. An EMG test was used to assess the order in which particular muscles were contracted in a given exercise on a 4-point scale, where 1 = incorrect technique and 4 = correct technique (activation of pelvic floor muscles with synergistic muscles relaxed). The test consisted of 11 tasks (exercises). Here we present results from the first and the last tasks. Correct pelvic floor contraction in the first task should reflect ability to prevent urine leakage in unexpected everyday situations. Correct contractions in the last task reflects resistance to fatigue. A smallest important change of 0.3 in the test score was assumed for assessment of the effect of training with magnitude-based inference. Results: During the first EMG test, correct technique was used by most women in the first task (score =  $3.2 \pm 1.1$ , mean  $\pm$  SD) but most women showed fatigue in the last task (score =  $2.9 \pm 0.8$ ). After six weeks, both groups improved performance in the first task, but there was a possibly small improvement in the controls relative to the training group (mean difference 0.3, 90% confidence limits  $\pm 0.5$ ). In the last task there was a likely small improvement in the training group relative to the controls (mean difference 0.6,  $\pm 0.6$ ). Conclusion: Training of the pelvic floor muscles may help maintain urinary function in pregnant women in situations where they experience fatigue of this muscle group due to supporting the growing uterus and fetus.

### EXERCISE TRAINING ON GOTO-KAKIZAKI RATS: INFLAMMATION STATE BEFORE THE BENEFICIAL EFFECTS ?

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*CRMBM*

Introduction: Physical activity is considered a crucial component of type 2 diabetes mellitus (T2DM) management, along with diet and medication. However, the beneficial effect of exercise on T2DM physiopathology cannot be only explained by weight loss since few years (1). In that context, the impact of regular physical activity on diabetic skeletal muscle function and bioenergetics independently of obesity warrants further investigation. The purpose of this study was to clarify this issue in Goto-Kakizaki (GK) rat, a model exhibiting a moderate T2DM in absence of obesity. Methods: GK rats (n = 8) performed 8 weeks of daily run on a treadmill (60 min at 20 m/min). Energy metabolism and mechanical performance were longitudinally investigated in gastrocnemius muscle through a multidisciplinary approach combining non-invasive techniques (NMR 31-phosphorus spectrometry and imaging), before (t0), at 4 and 8 weeks. In vitro assays were also performed in additional animals for measuring blood glucose and insulin. Results: Four weeks of exercise training decreased maximal oxidative capacity (Qmax: -33%), specific force generation (-45%) and oxidative energy production (-20%) compared to t0. After 8 weeks of exercise training, ATP production by creatine kinase reaction and anaerobic glycolysis pathways were increased by 42% and 26% respectively while Qmax returned at t0 value. However, specific force generation was slightly decreased (-15%) compared to t0. Discussion: Reduction of both oxidative ATP synthesis and maximal oxidative capacity after 4 weeks of exercise training indicates an impaired mitochondrial function that could be caused by the exercise induced transient inflammation state (2). After 8 weeks of training, observed alterations disappeared and beneficial effects on the GK model seem to emerge by enhancing ATP production from creatine kinase and anaerobic glycolysis pathway suggesting better glucose utilization. References: 1. Boulé NG, Haddad E, Kenny GP, Wells GA, Sigal RJ. Effects of Exercise on Glycemic Control and Body Mass in Type 2 Diabetes Mellitus. *JAMA* 286:1218-1227, 2001. 2. Azizbeigi K, Azarbayjani MA, Atashak S, Stannard SR. Effect of moderate and high resistance training intensity on indices of inflammatory and oxidative stress. *Res Sports Med* 23:73-87, 2015.

### THE ROLE OF THE AFRICAN SWIMMING FEDERATIONS IN THE PROMOTION OF HEALTH: PROTECTION OF THE ATHLETE'S HEALTH AND PROMOTION OF SWIMMING FOR HEALTH OF THE GENERAL POPULATION.

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Introduction: Over the last 5 years, international sport federations (IF), non-governmental organisations (NGO), and the United Nations (UN) have become more active and interested in the promotion of health through sport. Some IFs, such as FIFA and FINA have created "sport for all" programmes aimed at increasing general participation. The study "The role of International Sport Federations in the protection of the athlete's health and promotion of sport for health of the general population"(Mountjoy M, Junge A, 2013), showed that IFs aimed to protect the health of their elite athletes through various activities; however not all the IFs were involved in "sport for all" but fo-



cused more on elite athletes. The study "Competing with injuries: injuries prior to and during the 15th FINA World Championships 2013 (aquatics) (Mountjoy M, Junge A, Benjamin S, et al. 2014) concluded that there is a specific need for out-of-competition research. Methods As part of the study a survey was circulated by email and also in person (at the FINA Swimming World Championships 2014 (25m) / FINA Aquatics Convention in Doha) to all the FINA national swimming federations. Specific information was requested in relation to the following: Statistical information on membership, Medical Structure and facilities, Health Promotion activities, guidelines, Health regulations and directives, Development or implementation of any policies. The response rate in Africa was 62% (32 of the 51 African NFs replied). The multi-lingual survey was answered by the appropriate health representative or designated person of each NF. Results The responses indicate that for 41% of the African NFs one of their top priority objectives is to increase the number of elite athletes. For 50%, the top performance of their elite athletes is top priority, while 31% rank the health of elite athletes as a top priority. The results in relation to the general population show a lot of room for improvement; just 6% of the African NFs considers the health of the general population a priority for them. Discussion The analysis of the results obtained shows that there is a lack of awareness about using swimming as a health promotion tool in Africa. African NFs face significant barriers/ challenges; therefore health promotion is not a top priority for them. Swimming is not ranked as a top sport in African countries. Therefore is not considered or used a method of health promotion as much as it is in other developed countries. Conclusion The responses indicate that health promotion is not a priority in African NFs. References: Mountjoy M, Junge A, Alonso JM, et al. Sports injuries & illnesses in the 2009 FINA World Aquatic Championships. *Br J Sports Med* 2010;44:522-7. Mountjoy M, Junge A, Benjamin S, et al. 2014. Competing with injuries: injuries prior to and during the 15th FINA World Championships 2013 (aquatics). *Br J Sports Med* 2014;0:1-8. doi:10.1136/bjssports-2014-093991. Steffen K, Soligard T, Engebretsen L. Health protection of the Olympic athlete. *Br J Sports Med* 2012;46:466-70.

### EFFECTS OF WATER IMMERSION IN VARIOUS WATER LEVELS ON URINE VOLUME AND SUBJECTIVE MICTURITION DURING WATER EXERCISE

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 1 Graduate school, kawasaki university of medical welfare, 2 Kawasaki university of medical welfare, 3 Ray sports club okayama, 4 Saiseikai fitness and culture club, 5 Yasuda women's university

Purpose: The purpose of this study was to investigate the relationship of in water exercise to urine volume, subjective micturition, rating of perceived exertion (RPE), heart rate, blood pressure and rectal temperature during in water exercise. Methods: Six healthy male (age:  $21.8 \pm 0.4$  years, weight:  $68.5 \pm 7.2$  kg, height:  $176.2 \pm 2.7$  cm) subjects volunteered for this study. Each subject signed an informed consent form. The study was conducted in an indoor pool facility at K University, in 2014. This study consisted of two experimental conditions: the clavicle trial (C) and the greater trochanter trial (G). The water levels were set to the clavicle and the greater trochanter process. Subjects participated in both conditions on different days. Measurement items were urine volume, subjective micturition, RPE, heart rate, blood pressure (SBP: Systolic Blood Pressure / DBP: Diastolic Blood Pressure) and rectal temperature. The water temperature was 30 degrees Celsius. Both conditions began with 30 minutes in a sitting posture on land. Then, for the next 45 minutes, both conditions performed aquatics in water. Finally, for the last 30 minutes, both conditions were back on land in a sitting posture. Results: Urine volume and subjective micturition after immersion in the C condition was higher than that of G ( $p < 0.05$ ). RPE at immersion in the C condition was higher than that of G ( $p < 0.05$ ). Heart rate at immersion and recovery at 5 minutes in the C condition was higher than that of G ( $p < 0.05$ ). Rectal temperature at immersion, recovery at 5 minutes, recovery at 10 minutes and recovery at 15 minutes in the C condition was lower than that of G ( $p < 0.05$ ). SBP and DBP at immersion in the C condition were higher than that of G ( $p < 0.05$ ). Discussion: Venous return increases in water and urine formation rises and then the diuretic effect increases. Previous studies demonstrated that responses to the physical characterizations in water differed from those on land. Conclusion: Urine volume and subjective micturition increases through inundation in water. References: Onodera S, Yoshioka A, Nishimura K, Kawano H, Ono K, Matsui T, Ogita F, Hara H : Water exercise and health promotion, *The Journal of Physical Fitness and Sports Medicine*, 2(4), 393-399, 2013. Greenleaf LE : Physiological responses to prolonged bed rest and fluid immersion in humans. *Journal of Applied physiology*, 7, 619-633, 1984.

### RELATIONSHIP BETWEEN SHORT-FORM HEALTH SF36 QUESTIONNAIRE AND OXYGEN UPTAKE IN HEALTHY WORKERS

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Introduction Physical Activity (PA) is associated with better health levels (Sallis, 2009) and the Cardiopulmonary fitness recognized like one of the best indicators of Physical performance, which can be related with some items of Quality of Life (QL), therefore, the aim of this study was to analyze the relationship between the Quality of Life (QL) and cardiorespiratory fitness of health workers. Methods Sample was formed by 74 health workers (31 men, mean age 36.76 and 43 women, mean age 38.46), measured with the Short-Form Health Survey SF36 (Alonso, Prieto y Antó, 1995) and incremental cardiopulmonary test. Results  $Vo_2$ 's Mean values are higher in Men (39.84 ml/kg/min SD 7.91) than in women (30.74 ml/kg/min SD 5.89) but not significant. Men show higher scores than women but significant differences are present only in Physical Functioning, Role Physical ( $P < 0.05$ ) and Role Emotional ( $P < 0.01$ ) scales. Results showed that better cardiorespiratory fitness is related to higher scores in SF36. Discussion These findings suggest that insofar the values of  $Vo_2$ Max. in a healthy adult workers population is higher, are better the results obtained in the different items that the SF36 evaluated as to the perceived QL, therefore can be assumed to have a good fitness means having a better QL. References 1. Sallis RE. Exercise is medicine and physicians need to prescribe it! *Br J Sports Med*. 2009;43(1):3-4. doi: 10.1136/bjism.2008.054825. 2. Alonso J, Prieto L, Antó J. La versión española del SF-36 health survey (cuestionario de salud SF-36): Un instrumento para la medida de los resultados clínicos. *Med Clin*. 1995;104(20):771-776.

## Mini-Orals

### MO-PM17 Physiology: Endurance

#### EXERCISE-INDUCED PAIN TOLERANCE PREDICTS TIME TRIAL CYCLING PERFORMANCE

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Purpose: It has previously been suggested that tolerance of pain is an important factor in endurance performance (Mauger, 2014). However, pain sensation-perception is a complex process which is affected by the type of pain elicited. Therefore, to investigate the effect of exercise-induced pain (EIP) on endurance performance, it may be important to use an experimental pain model that reflects the aetiology of EIP. The purpose of this study was to compare the predictive capacity of experimental pain and EIP on exercise performance. Methods: Twenty one recreationally active male (n= 15) and female (n= 6) participants ( $27.5 \pm 5.5$  y;  $1.73 \pm 0.09$  m;  $72.3 \pm 14.3$  kg) were recruited for this study. Over a series of 3 experimental visits, participants completed traditional measures of experimental pain tolerance by cold pressor test (CPT), and pain pressure threshold via algometry (PPT). Participants were also assessed for their tolerance of EIP using an RPE-clamp cycling trial (Tucker et al. 2006). A standard VO<sub>2</sub>max test provided traditional predictors of endurance performance (VO<sub>2</sub>max, anaerobic threshold (AT), peak power output (PO<sub>peak</sub>)). Finally, participants completed a 16.1 km cycling time trial (TT). Results: No correlation was found between experimental pain measures and TT performance (mean pain in CPT;  $R = 0.28$ ; time lasted in the CPT;  $R = 0.35$ ; PPT;  $R = 0.31$ ,  $p > 0.05$ ). However, there was a significant correlation between EIP tolerance and TT performance ( $R^2 = 0.84$ ,  $p < 0.01$ ). Significant correlations were observed between TT performance and traditional measures of performance (VO<sub>2</sub>max;  $R = 0.48$ ,  $p = 0.029$ ; PO<sub>peak</sub>;  $R = 0.89$ ,  $p < 0.01$ ), with the exception of AT. Stepwise regression for pain predictor variables (mean pain in CPT, time lasted in the CPT, PPT, EIP) revealed that a significant model emerged ( $F_{1,19} = 44.65$ ,  $p < 0.01$ ) when only EIP was used to predict TT performance (Adjusted R Square = 0.69, Beta = 0.84). Conclusion: These findings suggest that EIP tolerance plays an important role in endurance performance and that it is an accurate predictor of TT cycling performance. However, traditional models of experimental pain do not predict exercise performance, likely because they represent very different pain pathways to EIP and so are interpreted differently. Consequently, their use in exercise-induced pain research should be treated with caution. References Mauger AR. (2014). Open access journal of sports medicine, 5:209. Tucker R, Marle T, Lambert EV, et al: J Physiol, 574(Pt 3):905-915. Contact Dr Alexis Mauger – l.mauger@kent.ac.uk

#### THE EFFECT OF RESPONSE INHIBITION ON CRITICAL POWER AND THE ANAEROBIC WORK CAPACITY

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The effect of response inhibition on critical power and the anaerobic work capacity The critical power concept is a mathematical model used to define as the highest sustainable rate of aerobic metabolism (CP) and the finite work capacity that is available above CP, known as  $W'$ . However, TTE tests are strongly influenced by perception of effort (PE), defined as "the conscious sensation of how hard, (Marcora, 2009a). Recent studies have demonstrated a negative effect of cognitive tasks involving response inhibition on PE during self-paced endurance tasks (Marcora et al., 2009b; Pageaux et al., 2014). Therefore, higher PE may limit TTE and subsequently alter the CP and  $W'$  independently of changes within the underlying muscle physiology. The aim of this study was to investigate this hypothesis. Methods Eleven trained cyclists completed 5 laboratory visits, first was to determine maximal aerobic power (MAP). In a randomised order, each cyclist completed four CP protocols under two conditions, following a cognitive task involving RI (incongruent Stroop Task) to exacerbate PE, and following a control (CON) task (reading a magazine). Both tasks lasted 30 min followed by a TTE trial. After 30 min of rest, each cyclist commenced a 2nd bout of the same 30 min cognitive task, with a subsequent TTE trial. The required PO for each TTE was at  $\Delta 40\%$ ,  $\Delta 60\%$ ,  $\Delta 80\%$ , and  $100\%$  MAP. RPE and HR were measured during each TTE with the slope of the response being calculated. Results are presented as mean + SD, CP and  $W'$  data were analysed by paired t-tests and all other results by two-way repeated-measures ANOVAs. Results Neither cognitive task induced any change in CP (RI  $253 \pm 51$  vs. CON  $247 \pm 58$ W;  $P > 0.05$ ), although  $W'$  was significantly reduced in the RI condition (RI  $22817 \pm 4487$  vs. CON  $29283 \pm 6266$  J;  $P < 0.01$ ). Perception of mental fatigue significantly increased as a result of RI compared to baseline and the CON task ( $P < 0.05$ ). There was no significant difference in perceived physical fatigue between conditions ( $P > 0.05$ ). However, pre-post BL accumulation was significantly lower after each TTE in RI condition ( $P = 0.03$ ). The slope of the RPE response was significantly lower in the RI condition due to a higher initial rating ( $P = 0.04$ ). Discussion The results of this study demonstrate that RI has no effect of CP, but does reduce the  $W'$  in trained cyclists. This finding is interesting given that the CP concept is traditionally explained using purely physiological parameters. We demonstrate that mental fatigue induced by RI can alter the work-time relationship, reducing  $W'$ . Lower BL accumulation in TTEs following RI suggests that cyclists were not be able to fully expend  $W'$  even though they exercised to exhaustion. Reference Marcora SM (2009a). Encyclopedia of Perception, 380-382. Marcora SM, Staiano W & Manning V (2009b). J Appl Physiol 106, 857-64. Pageaux B, Lepers R, Dietz KC, Marcora SM (2014). Eur J Appl Physiol 114, 1095-105.

#### THE VO<sub>2</sub> PLATEAU IS RELATED TO THE VO<sub>2</sub>-WORK RATE SLOPE AT SUBMAXIMAL RAMP EXERCISE

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Introduction A plateau in oxygen uptake is the only valid criteria indicating that a maximum oxygen uptake (VO<sub>2</sub>max) has been achieved. However, during cycling exercise only 30-50% of the subjects show a deflection of oxygen uptake before exercise termination. The physiological reasons of the VO<sub>2</sub> plateau occurrence in some but not all subjects are still unclear. From studies observing the VO<sub>2</sub>-work rate slope ( $\Delta VO_2/\Delta W$ ) at submaximal ramp exercise it is well known that there are considerable differences in  $\Delta VO_2/\Delta W$  ( $9-11$  ml\*min<sup>-1</sup>\*W<sup>-1</sup>) between subjects, which may reflect differences in biomechanical efficiency and /or distinct VO<sub>2</sub>-onset kinetics. The latter does affect the O<sub>2</sub>-deficit at increasing workload which may modulate the ability to continue the test at plateauing VO<sub>2</sub> response. Whether the magnitude of  $\Delta VO_2/\Delta W$  affects the manifestation of the VO<sub>2</sub>max, is unknown. Therefore we tested the hypothesis that the incidence of a VO<sub>2</sub> plateau is linked with a high  $\Delta VO_2/\Delta W$  at submaximal exercise. Methods 15 moderately to well-trained male subjects (mean  $\pm$  SD age:  $25.7 \pm 2.4$  yrs; high:  $182.3 \pm 7.3$  cm; body mass:  $81.6 \pm 6.9$  kg; VO<sub>2</sub>max:  $4.1 \pm 0.4$  l\*min<sup>-1</sup>) performed an incremental ramp test ( $25$  W\*min<sup>-1</sup>) and a VO<sub>2</sub>max-verification test (constant load exercise until exhaustion at 95% peak power) on a cycling ergometer. The VO<sub>2</sub>-

work rate slopes have been calculated from the ramp test using linear regression analyses. A VO<sub>2</sub> plateau has been assumed if the increase of VO<sub>2</sub> during the last minute of the ramp test was <2.1 ml\*kg<sup>-1</sup>\*min<sup>-1</sup>. For the quantification of the VO<sub>2</sub> plateau the differences (residuals) between the extrapolated VO<sub>2</sub>max from the submaximal VO<sub>2</sub>-work rate slope and the measured VO<sub>2</sub>max has been calculated. Subjects with a considerable higher VO<sub>2</sub>max value (>100 ml\*min) in the verification test (>100 ml\*min) have been removed from further analyses. Results of 6 of the 15 subjects showed a plateau at VO<sub>2</sub>max (40%). There were no differences with regard to the maximum blood lactate (12.7 ± 1.5 vs. 12.2 ± 1.8 mmol\*l<sup>-1</sup>) maximum respiratory exchange ratio (1.19 ± 0.06 vs. 1.17 ± 0.03) and maximum heart rate (186 ± 7 vs. 189 ± 9 l\*min<sup>-1</sup>) between the groups of plateau and non-plateau subjects (all p>0.05). ΔVO<sub>2</sub>/ΔW is significantly higher in the plateau group than in the non-plateau group (11.6 ± 0.6 vs. 10.8 ± 0.5 ml\*W<sup>-1</sup>; p<0.05). Furthermore the ΔVO<sub>2</sub>/ΔW is significantly correlated with the differences (residuals) between the extrapolated VO<sub>2</sub>max and the measured VO<sub>2</sub>max (r = 0.78; p<0.01). Conclusion Subjects with a steeper ΔVO<sub>2</sub>/ΔW have a greater chance to show a plateau at VO<sub>2</sub>max.

## THE EFFECT OF CARBOHYDRATE MOUTH RINSE ON SIMULATED XC-SPRINT PERFORMANCE

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**Introduction** In cross country skiing(XC) sprint, lasting ~3min, athletes reaches intensities of >90% VO<sub>2</sub>max, with >12 mmol/L blood lactate and close to 100% of HRmax (Stöggl, Lindinger, & Müller, 2007). Carbohydrate (CHO)mouth rinse protocol have been showing beneficial effects on self paced high intensity endurance performance (Jeukendrup, Rollo, & Carter, 2013), possible by the effect of a central response to an oral stimuli of the CHO(Gibson, Lambert, & Noakes, 2001). The primary aim was to investigate if a 10 sec CHO solution mouth rinsing protocol improved the performance in a simulated (XC) sprint compared with control (CON). **Method** Seven well trained XC skiers (Male, n=4; Female, n=3) attended the laboratory four times in a placebo controlled, randomized double-blind study. The participants completed four simulated sprints, two (CON) and two experimental rinse protocols; one with a CHO solution and one with a placebo (PLA). The control trials were used to calculate the typical error for time and power output (1.1 sec and 17.4 watt respectively). In the experimental protocol the participants rinsed a 6,4% maltodextrin solution before completed a sprint (800 m for female and 1000 m for male). Time to completion, maximal power output, VO<sub>2</sub>, RPE and post capillary blood sample were measured. Data were analyzed by using ANOVA. **Results** Time to completion was not different with CHO compared with PLA or CON (203,0±16,5 sec, 202,3±15,7 sec, 203,3±14,6 sec) respectively (F=0.01; p >.05). Maximal power output was no different between trials (CON 301±87, PLA 301±83, CHO 302±98; F=0.00; p>.05). Post blood lactate at 15 min were similar between CHO, CON and PLA (9,9±3,9 mmol/L, 7,6±4,0 mmol/L, 10,1±3,7 mmol/L respectively, p >.05). There were no differences between groups in VO<sub>2</sub>max (CON 5.1±1.5L, PLA 5.0±1.6L, CHO 4.9±1.3L; F= 0.05; p>.05). **Discussion** CHO mouth rinse does not improve performance in high intensity XC sprint on time to completion, power output or blood lactate parameters. It can be argued that the peripheral fatigue stimuli is greater during a XC sprint than a possible oral stimuli can alter and that there may be an threshold in intensity and duration for a beneficial effect of CHO mouth rinse. **Reference** Gibson, A. S. C., Lambert, M. I., & Noakes, T. D. (2001). Neural control of force output during maximal and submaximal exercise. *Sports Medicine*, 31(9), 637–650. Jeukendrup, A. E., Rollo, I., & Carter, J. M. (2013). CARBOHYDRATE MOUTH RINSE: PERFORMANCE EFFECTS AND MECHANISMS. *Sports Science*, 26(118), 1–8. Stöggl, T., Lindinger, S., & Müller, E. (2007). Analysis of a simulated sprint competition in classical cross country skiing. *Scandinavian Journal of Medicine and Science in Sports*, 17: 362–372 Contact andreas.karstrom@miun.se

## MYOGLOBIN AND NGAL CHANGES IN ULTRA-MARATHON RUNNERS AFTER THE RACE

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**Do not insert authors here** **Introduction** During vigorous exercise blood is shunted away from major organs including kidneys. Effective renal plasma flow is reduced during exercise. When strenuous work is performed renal blood flow may fall to 25% of the resting value. Several factors can play the role in possible damage the kidney beyond repair during physical exertion. **Methods** The group of volunteers in this study consisted of ultra-marathon runners (n=28). The subjects participated in three ultra-marathon (100 km, 12--h and/or 24-h runs). Prior to and after finishing the race blood samples were obtained from the cubital vein. Wide range of results was achieved. The fastest 100 km runner finished in 7:23 h, the best result in 24-h run was 181 km. The results of myoglobin and neutrophil gelatinase-associated lipocalin (NGAL) are presented in this study. **Results** Following ultra-marathon running performance all participants had significant increased levels in both myoglobin (82.3 to 3072.3 µg/l, P < 0.001) and NGAL (124.5 to 266.7 ng/ml, P < 0.001). There were significant individual differences among the runners, not only in the initial "resting" values, but in post-race values especially. They weren't correlated to the duration of the running time. **Discussion** Muscle damage during ultra-endurance running performance may result in rhabdomyolysis and myoglobinuria (1) and is occasionally associated with acute renal failure. When dehydration, hypovolaemia and other factors are added to the myoglobin load, the kidney may respond by ceasing its excretory and metabolic functions (2). Post-exercise increase of serum creatinine and NGAL met criteria of acute kidney injury in some of ultra-endurance runners. (3) Most cases of rhabdomyolysis do not require hospitalization and individuals recover within one week. However, in certain individuals rhabdomyolysis can be severe. **References** Schiff HB et al.(1978). *QJM. Int. J. Med* 47(4): 463-472 Milne CJ (1988) *Sports Med.* 6 (2): 93-106 *Sports Med.* 6 (2): 93-106 Lippi G. et al. (2012) *CCLM* 50 (9): 1585-1589 Contact: novakj@lfp.cuni.cz

## EFFECTS OF LOW-INTENSITY EXERCISE IN THE MORNING ON PHYSIOLOGICAL RESPONSE DURING UNSTEADY WORKLOAD EXERCISE IN THE EVENING

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**Aim:** This study aimed to examine the effects of low-intensity exercise in the morning on physiological response during unsteady workload exercise in the evening. **Methods:** The study included 9 healthy men, and they provided written informed consent before participation. We established two experimental conditions: 15 min of bicycle exercise at 40% of maximum oxygen consumption (VO<sub>2</sub>max) at 8:30 AM (morning exercise (ME) condition) and rest in the sitting posture during the same time (control (C) condition). Measurements of physiological parameters were performed at 16:00 with the participant at rest in the supine position. All the participants performed cycling exercises for 32 min at 16:30. The evening exercises were performed in 2 parts: a calibration part and a gradual increase and decrease of workload exercise part. The calibration test consisted of three 4-min bouts of exercise at 20%, 60%, and 40% VO<sub>2</sub>max. The unsteady

exercise test consisted of 4-min bouts of exercise with gradual increases and decreases in workload at 20% and 60% VO<sub>2</sub>max. Heart rate (HR), blood pressure (BP), and oxygen uptake were measured in both experiments. Maximal and minimal values, amplitude, and phase lags were measured with each cycle of unsteady workload exercise. All participants went to bed at 23:00 and awoke at 07:00 on each experimental day. Each participant had breakfast at 07:30 and lunch at 12:30. Results and Discussion: In a resting state before the evening exercises, HR and double product (DP) were significantly higher in the ME condition than the C condition. The BP, oral temperature, and ln HF, an index of cardiac parasympathetic nervous system modulation, of the participants were not compared between the ME and C conditions. HR, systolic BP (SBP), and DP at 60% and 40% VO<sub>2</sub>max were significantly lower in the ME condition than the C condition. However, oxygen uptake did not show a significant difference between 2 conditions. The phase lags of HR and oxygen uptake with the increase and decrease of the workload were significantly shorter in the ME condition than the C condition. The amplitude of oxygen uptake was significantly larger in the ME condition than the C condition. Previous studies have reported that low-intensity exercise in the morning significantly enhanced exercise performance in the evening in terms of the jumping power, bendability, cardiorespiratory endurance, and anaerobic capacity. Our results show that low-intensity exercise in the morning can be considered an effective conditioning method on the day of a sporting event. In conclusion, the physiological response during exercise in the evening is enhanced by low-intensity exercise in the morning.

### LONGER TRAINING EXPERIENCE INDUCED GREATER EFFICIENT SYSTOLIC FUNCTION IN ENDURANCE ELITE ATHLETES

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Introduction High performance in endurance athletics is maintained during a large range of age by elite athletes and depends largely on aerobic capacity which in turn depends in part of the cardiovascular system. The aim of this study was to identify changes in specific cardiac mechanisms related to aerobic capacity along with the training experience in elite athletes. Methods Twenty-eight male elite athletes in endurance with a strict adherence to high performance training for years were divided into two groups according to age and years of training at high level. Short-training experience (STE) group (n=16, aged 25.6±3.0 years and 8.9±3.0 years of high performance training) and long-training experience (LTE) group (n=12, aged 34.7±2.8 years and 15.7±3.9 years of high performance training). All subjects underwent a standard echocardiographic examination at rest and the morphological parameters of the left atrium, left ventricle and systolic function were obtained. Results No changes were found in morphological parameters on left atrium. There were no differences in any morphological parameters of the left ventricle, although a tendency towards statistical significance was found in the left ventricular internal diameter which was higher in LTE than in STE (30.97±1.62 mm; 32.33±2.28 mm, P<0.07). Ejection fraction was ~7% higher in LTE than in STE group (59.81±6.27 %; 64.33±4.09 %, P<0.05) as well as fractional shortening that was ~8.5% higher in LTE than in STE group (32.44±4.44 %; 35.58±3.28 %, P<0.05). Discussion Longer training experience in elite athletes is associated with a higher ejection fraction and a higher fractional shortening despite the similar morphological parameters on the left ventricle. These data suggests an increase of cardiac efficiency associated with a progressive increase in cardiac contractility along the years in high performance training. Systolic function continues to improve with the experience training without significant myocardial structural changes in elite endurance athletes. The improvement could partly explain the maintenance of performance along the years in endurance sports in cardiovascular system. References - Left ventricular systolic performance is improved in elite athletes. *Eur J Echocardiogr.* 2011 Jul - Assessment of the left ventricular chamber stiffness in athletes. *Echocardiography.* 2011 Mar - Atrial and ventricular functional and structural adaptations of the heart in elite triathletes assessed with cardiac MR imaging. *Radiology.* 2010 Oct

### EFFECT OF SAMBA DANCE IN CARDIOPULMONARY FITNESS AND BODY COMPOSITION IN WOMEN DANCERS.

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INTRODUCTION Studies have shown that dancing regularly as a physical activity can improve fitness (Di Blasio et al., 2009). However samba, typically Brazilian dance, is not well known about the impact that its practice may cause on individuals who perform it. The objective of this study was to investigate the effect of 12 weeks of samba dance practice in cardiorespiratory fitness and body composition of women dancers who parade in samba schools. METHODOLOGY Longitudinal study, almost experimental. Thirteen sedentary women, 20 to 40 years old, body mass 52,1 and 71,3 kg and height 156 and 175 cm, participants of the pre-carnival trials of a samba school in Brazil. The intervention performed were samba dance sessions, lasting 60 minutes, three times per week for 12 weeks. Maximal heart rate (HR<sub>max</sub>) in the trials ranged from 66% to 85% of HR reached in the stress test and was monitored by a heart rate monitor. Pre and post intervention subjects were evaluated the cardiorespiratory function by ergospirometry and their body composition by skinfold. RESULTS Increased by 17%, 13% and 8% of maximal oxygen consumption (VO<sub>2</sub>max), oxygen pulse rate (PO<sub>2</sub>max) and respiratory exchange rate (RER<sub>max</sub>), respectively (P <0,001). Decreased by 11% body fat percentage (BF%) and 12% fat mass (FM) and lean body mass (LBM) increased by a pound (P <0,001). DISCUSSION Of intermittent characteristic, the intensity and the amount of physical effort required in tests resulted in adjustments that have caused improvements in aerobic system of individuals (Helgerud et al., 2007) and body composition while maintaining the resting metabolic rate at high levels for a long period (Gerber et al., 2014) which contributed to decrease body fat levels. Although the type of exercise is not specific to muscle gain, those found increases (Angioi et al., 2009) corroborate to previous studies where lean body mass indexes for dancers are smaller in relation to sports practitioners in general, but larger than those found in sedentary situation. REFERENCES Angioi M, Metsios G, Koutedakis Y, Wyon MA. Fitness in contemporary dance: a systematic review. *Int J Sports Med* 2009; 30 (7): 484. Di Blasio A, De Sanctis M, Gallina S, Ripari P. Are physiological characteristics of Caribbean dance useful for health? *Journal of Sports Medicine and Physical Fitness.* 2009; 49 (1): 30-4. Gerber T, Borg ML, Hayes, Stathis CG. High-intensity intermittent cycling increases purine loss compared with workload-matched continuous moderate intensity cycling. *Eur J Appl Physiol.* 2014; 114 (7): 1513-1520 Helgerud J, Høydal K, Wang E Karlsen T, Berg P Bjerkaas M, et al. Aerobic high-intensity intervals improve VO<sub>2</sub>max more than moderate training. *Med Sci Sports Exerc.* 2007; 39 (4): 665-671. CONTACT via email ciceracduarte@usp.br

## ASSESSMENT OF PHYSICAL PERFORMANCE OF THE POLISH PARALYMPIC TEAM IN NORDIC SIT-SKIING IN THREE CONSECUTIVE PARALYMPIC GAMES <2002, 2006, 2010>

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Assessment of physical performance of the Polish Paralympic team in Nordic sit-skiing in three consecutive Paralympic Games (2002, 2006, 2010) Background: Systematic and comprehensive long-term follow-up is essential in the assessment of athletes' performance. Monitoring of the training process is necessary to achieve optimal physical fitness. Objective: To present the physiological performance and health condition of cross country sit-skiers with lower-limb disabilities based on ten-year follow-up and to design a comprehensive assessment model in the context of the athletes' disability and relating to the systematic physical training. Methods: The follow-up encompassed three athletes, of whom two participated in all three Paralympic Games (PGs). Each athlete underwent a preparticipation medical examination (PPE), followed by the incremental arm cranking test. The following values were determined: minute ventilation of lungs (VE), oxygen consumption (VO<sub>2</sub>), carbon dioxide production (VCO<sub>2</sub>), heart rate (HR), maximal oxygen uptake (VO<sub>2max</sub>) and lactate threshold (LAT). Body weight (BW) and fat percent (%F) were determined before and after test. Results: The comparison of all results demonstrates their sinusoidal character. The data for various physical, physiological and biochemical measurements showed a gradual increase in the athletes' endurance capacity, reaching the optimal value just before PG. Discussion: Endurance depends on a number of factors, such as: body type and build, effort energetics, psychological factors, muscle and joint coordination, thermoregulation, water and electrolyte metabolism. The impact of these factors on endurance varies depending on the type, intensity and duration of physical activity. In disabled sports, the type of motor disability modifies all of the aforementioned factors. In the available literature, the characteristics of endurance abilities of sit-skiers is most frequently based on the measurement of minute oxygen uptake as the main index of physical fitness. This aspect has gained further importance in view of the current regulations regarding disabled cross-country skiers. Conclusions: Test results depended on the training-related level of endurance at particular points of the follow-up and the general health condition. The increase in endurance parameters shortly before PGs reflects the peak fitness level. The obtained results facilitated a precise analysis of the athletes' adaptation mechanisms. As a result, optimal training was offered, leading to the Paralympic Games. References: Bernardi M, Guerra E, Di Giacinto B, Di Cesare A, Castellano V, Bhambhani Y. (2010). *Med. Sci. Sports Exerc.*, 42, 1200–1208. Vanlandenwijck Y, Thompson W. (2011). *The Paralympic Athlete*. Wiley-Blackwell. Bernardi M, Carucci S, MD, Faiola F, MD, Egidi F, Marini C, Castellano V, Faina M. (2012). *Clin J Sport Med.*, 22, 26–30. Contact: w.gawronski@medicinasportiva.pl

## Mini-Orals

### MO-PM19 Physiology: Thermoregulation, Fatigue

#### COMBINED EFFECTS OF HYPERTHERMIA AND CIRCADIAN RHYTHM ON AEROBIC AND ANAEROBIC PERFORMANCES IN THE HEAT

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Introduction Both aerobic and anaerobic exercise performances have a diurnal variation. As commonly reported in previous studies, circadian rhythm in exercise performance is low in the morning and peaks in the evening. It has been demonstrated that hyperthermia before exercise attenuates subsequent exercise performance in the heat. However, combined effects of passive hyperthermia and the time-of-day on both aerobic and anaerobic exercise performances in the heat have not been systematically evaluated. Therefore, the aim of this study was to examine the effects of passive hyperthermia and circadian rhythm on aerobic and anaerobic exercise performances in the heat. Methods Eight male volunteers completed four trials which involved anaerobic and aerobic cycling performance tests in a climatic chamber (30°C, 50% RH) at two different times-of-day: 08:00 (morning) and 17:00 (evening) h. The anaerobic performance test consisted of 10 sec maximal sprints at 5 kp to determine the maximal anaerobic power. The aerobic performance test consisted of cycling at 80% maximum oxygen uptake until exhaustion to determine exercise time to exhaustion. Participants cycled after: a 30 min seated rest in the morning (AR) and evening (PR), and a 30 min water immersion at 40°C to the upper chest in the morning (AH) and evening (PH). Rectal temperature, skin temperature (chest, upper arm, thigh and calf), heart rate, skin blood flow and blood pressure were recorded at rest and during exercise. Results Rectal temperature [AR 36.8 ± 0.4°C; AH 37.9 ± 0.2°C; PR 37.3 ± 0.3°C; PH 38.0 ± 0.2°C; p < 0.0001] and mean skin temperature [AR 30.9 ± 0.8°C; AH 36.7 ± 1.0°C; PR 31.6 ± 0.8°C; PH 35.9 ± 1.4°C; p < 0.0001] at the start of exercise were higher in AH and PH than in AR and PR. Maximal anaerobic power was not different between the trials (AR 11.5 ± 1.7 W/kg; AH 12.5 ± 1.9 W/kg; PR 11.7 ± 1.4 W/kg; PH 12.0 ± 1.9 W/kg; p = 0.24). Exercise time to exhaustion was reduced in AH (15 ± 8 min) and PH (24 ± 9 min) than in AR (39 ± 16min; p < 0.05), and in AH than in PR (43 ± 24 min; p < 0.05). At the point of exhaustion, rectal temperature, mean skin temperature, heart rate and cutaneous vascular conductance were not different between the trials. Conclusion This study demonstrates that passive hyperthermia before exercise elicits significant reductions in aerobic exercise performance in the heat in the morning, but this response is not observed in the evening. Moreover, hyperthermia and circadian rhythm do not influence anaerobic exercise performance in the heat. Contact hotani@himeji-du.ac.jp

#### IS A PERCEPTUAL STRAIN INDEX SUBSTITUTING THERMAL COMFORT FOR THERMAL SENSATION A MORE APPROPRIATE PREDICTOR OF PHYSIOLOGICAL STRAIN?

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INTRODUCTION: The perceptual strain index (PeSI) has been identified as a practical indicator for predicting physiological strain [1]. The PeSI combines the subjective scales of thermal sensation and rating of perceived exertion (RPE) and expresses strain on a zero to ten metric. While the PeSI shares a moderate association with the physiological strain index (PSI), the correlation between the interrelated variables of thermal sensation and core temperature has been questioned [2]. Therefore, this study aimed to determine if substituting thermal comfort for thermal sensation improved the ability of the PeSI to predict its physiological analogue. METHODS: Seventeen healthy

males (age  $23.4 \pm 2.5$  yrs; height:  $178.2 \pm 5.2$  cm; weight:  $78.5 \pm 7.9$  Kg;  $VO_{2max}$   $57.5 \pm 5.3$  ml/kg/min) wore four separate chemical protective ensembles (weights: 2.05; 3.75; 4.15; 15.4 Kg) and undertook trials in environmental conditions equivalent to wet bulb globe temperature 21, 30 or 37 °C while treadmill walking at 4 km/h and 1% grade. Heart rate, core temperature, thermal sensation, thermal comfort and RPE were recorded during trials. The PSI and the original and revised PeSI were calculated at 15-minute intervals. To determine the ability to predict physiological strain of each PeSI the absolute agreement and paired sample t-tests were calculated: 1) across the entire physiological strain scale, and; 2) using three arbitrary strain categories: No/little (NL): 0-2.9; low-moderate (LM): 3-6.9; and high-very high (HVH): 7-10. RESULTS: The mean bias (95% limits of agreement) between the original PeSI and PSI was  $1.5 \pm 1.5$  (-1.4 to 4.4), between the revised PeSI and PSI was  $-0.6 \pm 1.5$  (-3.5 to 2.3) and for the three arbitrary categories was:  $2.4 \pm 1.0$  (0.4 to 4.36) and  $0.2 \pm 1.1$  (-2.0 to 2.4) for NL;  $1.1 \pm 1.2$  (-1.3 to 3.5) and  $-1.0 \pm 1.2$  (-3.4 to 1.4) for LM; and  $-2.4 \pm 1.1$  (-4.6 to -0.2) and  $-0.4 \pm 1.1$  (-2.6 to 1.8) for HVH. The revised PeSI displayed significantly ( $P < 0.001$ ) less mean bias across the entire scale and during NL and LM strain; and significantly ( $P < 0.001$ ) greater mean bias during HVH strain. DISCUSSION: The revised PeSI was a significantly better predictor across the entire scale and during NL and LM strain. However, when strain was considered HVH, the revised PeSI was a significantly poorer predictor. Due to the increased risk of an adverse health event associated with exposure to HVH levels of strain, the original PeSI remains the most appropriate practical predictor of physiological strain.

### SEX COMPARISON OF LEUKOCYTE HSP72 MRNA UP REGULATION DURING HEAT ACCLIMATION

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1: Centre for Sport and Exercise Science and Medicine, University of Brighton, UK. 2: Department of Sport Science and Physical Activity, University of Bedfordshire, UK. Introduction Thermotolerance is acquired following repeated exposure to thermal stress, with phenotypical cellular adaptation, seen - most notably heat shock protein 72 (Hsp72). Thermotolerance reduces disruptions to cellular homeostasis by principally, but not exclusively, increasing basal Hsp72 during and post stress, following transcription of its gene (Hsp72 mRNA), as part of the heat shock response (HSR). Although, stress mediated sex specific differences in the Hsp72 protein have been seen (Morton et al., 2009, Gillum et al., 2013), they have not been examined at an mRNA level via qRT-PCR across the course of heat acclimation (HA). The aim of the current study was to determine whether inhibition of the HSR occurs at an mRNA level via measurement of the leukocyte Hsp72 mRNA response across a heat acclimation programme. Methods Five physically active males ( $45.69 \pm 4.37$  ml.kg<sup>-1</sup>.min<sup>-1</sup>) and females ( $46.23 \pm 4.11$  ml.kg<sup>-1</sup>.min<sup>-1</sup>) performed 10 controlled hyperthermia HA sessions. HA sessions involved a 90 minute exposure to 40°C, 40% relative humidity. Exercise intensity was set at 65%  $VO_{2max}$  and adjusted with work-rest intervals to maintain a rectal temperature ( $T_r$ ) of  $\sim 38.5^\circ\text{C}$ . Leukocyte Hsp72 mRNA was measured pre and post day 1, 5 and 10 of HA via qRT-PCR to determine the HSR. Results No differences were observed in mean  $T_r$  (day 1:  $38.25 \pm 0.19^\circ\text{C}$ , 5:  $37.95 \pm 0.58^\circ\text{C}$ , 10:  $38.21 \pm 0.10^\circ\text{C}$ ;  $p > 0.05$ ) and heart rate (day 1:  $149 \pm 11$  beats.min<sup>-1</sup>, 5:  $146 \pm 9$  beats.min<sup>-1</sup>, 10:  $146 \pm 11$  beats.min<sup>-1</sup>;  $p > 0.05$ ) over time or between sexes since controlled hyperthermia HA was adopted. Mean exercise power increased over time (day 1:  $74 \pm 19$  W, 5:  $101 \pm 27$  W, 10:  $107 \pm 28$  W;  $p \leq 0.05$ ). Hsp72 mRNA increased pre to post on day 1 (1.70  $\pm$  0.76 fold, 3.92  $\pm$  1.78 fold;  $p = 0.040$ ) and 5 (1.63  $\pm$  0.75 fold, 3.51  $\pm$  1.70 fold;  $p = 0.019$ ), there were no differences on day 10 (1.84  $\pm$  0.54 fold, 3.10  $\pm$  1.44 fold;  $p = 0.299$ ). There were no differences in Hsp72 mRNA expression between sexes. Discussion Males and females demonstrate comparable physiological strain and HSR to HA. The comparable transcription of Hsp72 mRNA in all participants' suggests there is no difference in the endogenous criteria to elicit the HSR between sexes. Data suggests translation of leukocyte Hsp72 may be hindered, consequently mitigating the attainment of thermotolerance in females. References Morton JP, Holloway K, Woods P, Cable NT, Burniston J, Evans L, Kayani A, McArdle A. (2009). Muscle Nerve, 39, 230-233. Gillum T, Kuennen M, Gourley C, Dokladny K, Schneider S, Moseley P. (2013). Int J Endocrinol Metab 11(4), e8739. Contact Jessica Mee: J.Mee@brighton.ac.uk

### EFFECT OF COLD EXPOSURE ON PROPRIOCEPTION AND COGNITIVE FUNCTION

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Background: Proprioception has been identified as an important factor of performance and injury prevention in downhill skiing. Recent evidence showed that cold exposure affects balance, which suggests that it might also affect proprioception. Unfortunately, humans have minimal acclimatization capabilities to cold exposure and winter sports athletes are likely to be affected by such alterations. The current study aimed to investigate the effects of cold exposure on proprioception and cognitive function in elite winter sports athletes and recreationally active individuals. Methods: 22 international-level Alpine skiers ( $179 \pm 4$ cm,  $83 \pm 6$ kg,  $26 \pm 4$  yrs) and 14 recreationally active participants ( $178 \pm 5$ cm,  $78 \pm 5$ kg,  $33 \pm 6$  yrs) were tested in a thermoneutral ( $24^\circ\text{C}$ ) and a cold ( $8^\circ\text{C}$ ) laboratory, in a counterbalanced order. Each experimental session included 10 min of rest followed in randomized order by a proprioception test (i.e. ankle eversion movement discrimination,  $\sim 10$ min) and a cognitive test (OTS: one touch stockings of Cambridge,  $\sim 10$ min). Affective (PANAS: positive and negative affect schedule), perceptual (TC: thermal comfort; TS: thermal sensation) and physiological (oral and skin temperatures) responses were also recorded. Results: Cold exposure significantly decreased the oral ( $34.9 \pm 0.7$  vs.  $36.2 \pm 0.4^\circ\text{C}$ ) and skin ( $26.0 \pm 1.8$  vs.  $30.8 \pm 1.0^\circ\text{C}$ ) temperatures as well as TS and TC, and increased the amount of negative affects (negative/positive ratio: 41% vs. 51%) in both groups ( $p < 0.05$ ). Proprioceptive acuity was significantly better in the elite skiers than in the control group (average error:  $0.46 \pm 0.12$  vs.  $0.55 \pm 0.12$  deg,  $p < 0.05$ ), but was not affected by environmental temperature ( $p > 0.30$ ). Cognitive performance during both simple (OTS-4) and complex (OTS-6) tasks were similar between the elite skiers and the recreationally active control in the temperate environment, but decreased with cold exposure in the control group only ( $p < 0.05$ ) becoming lower than in elite skiers in the cold environment ( $p < 0.05$ ). Conclusion: Cold exposure induced similar physiological and affective alterations in elite winter sports athletes and recreationally active individuals. However, these alterations did not affect proprioceptive acuity, which was better in elite skiers than recreationally active controls. Cold exposure impaired cognitive function in recreationally active individuals but not in elite winter sports athletes.

## CORE BODY TEMPERATURE RELATIONSHIPS WITH OTHER PHYSIOLOGICAL VARIABLES DURING INCREMENTAL CYCLING TEST

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**Introduction** Two basic facts link core body temperature (CBT) and metabolism. The amount of heat muscles produce is related to the amount of work they perform. The more intense is workout, the more heat they produce. Heat dissipation from dynamically contracting muscles consists of heat transfer to the core of the body and to surrounding tissues or environment (1) Using new noninvasive sensor technology (SpotON, 3M, USA) for measurement of CBT (2), our goal was to find how significant can be connection between temperature and oxygen consumption (VO<sub>2</sub>, ml/min/kg) and some other physiological variables in controlled conditions during incremental cycling test. **Methods** Subjects consisted of 20 highly trained male competition cyclists, age  $19.9 \pm 3.0$  yr., body height ( $182.3 \pm 4.4$  cm) and body mass ( $71.2 \pm 5.3$  kg). After 15 min warm-up on their bicycle set up on a cycle ergometer (Cyclus 2, Germany) cyclists proceeded with incremental test (initial load 100W), increase 20 W min<sup>-1</sup> to volitional fatigue. Ambient temperature was between 21.5 C. Heart rate, ventilatory, and gas data were collected during the test with the metabolic cart (Cosmed CPET, Italy). Blood samples (10µl) for determination of lactate values were analyzed (BIOSEN C\_Line, Germany) before warm-up, immediately after test and 5 min after a recovery phase. CBT was measured with SpotOn system (3M, USA). Data from testing were imported into MATLAB (Mathworks, USA) for further analysis. **Results** Interval of data analysis during test was started 60s after beginning of test protocol and collected during next 840s (from 100-400W) for all subjects. Normalized data for 20 subjects show statistically significant high linear correlation between CBT and VO<sub>2</sub> ( $R^2=0.978$ ). Slope of linear regression line between CBT and VO<sub>2</sub> compared with VO<sub>2</sub> max show statistically significant correlation ( $R^2=0.71$ ). **Discussion** The appropriate approach, novel in humans performing dynamic exercise, would be to measure heat production, power output and aerobic and anaerobic energy turnover (1). CBT is not interesting physiological variable not only because it is connected with metabolism but also because it influences other variables by itself (heart rate, oxygen consumption...) and is a factor responsible for reducing voluntary activation during brief voluntary isometric contractions and those temperature-induced changes influence the contractile properties of muscle (3). Our study showed statistically significant very high linear correlation between CBT and VO<sub>2</sub> in incremental cycling test conditions. Another interesting finding is the positive correlation between slope of linear regression line of CBT / VO<sub>2</sub> and VO<sub>2</sub> max.

## HIIT IN THE HEAT: A HOT NEW COMBINATION?

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**Introduction** High-intensity interval training (HIIT) appears to provide a superior cardio-metabolic conditioning stress to moderate-intensity continuous training (Weston et al. 2014). Heat stress per se also provides a stimulus for adaptation, and has recently been shown to potentiate cardiovascular adaptations to exercise training. The aim of this study was to examine whether HIIT performed in the heat provided an accumulative benefit for cardiovascular conditioning. **Methods** In a randomised crossover design, 10 sedentary participants (5 female; mean  $\pm$  SD;  $33 \pm 9$  y;  $189.4 \pm 9.1$  cm;  $82.5 \pm 15.0$  kg;  $38 \pm 5$  mL/kg/min) completed two 8-wk HIIT regimes (5 d/wk cycle ergometry progressing to 90-95% Heart rate (HR) max, supplemented with resistance band exercises), separated by 8-wk washout. One regime was in temperate (EX+TEMP;  $23 \pm 2^\circ\text{C}$ ,  $36 \pm 5\%$  RH) and one in hot (EX+HEAT;  $40 \pm 0^\circ\text{C}$ ,  $61 \pm 2\%$  RH) conditions. HR and perceived exertion (RPE) were recorded throughout, but are analysed here for just 45-min sessions in weeks 1, 3, 5 and 7. Aerobic power (VO<sub>2</sub>max), body composition (BIA) and arterial pressures were tested before and after each regime. Data were analysed using RM ANOVA. **Results** Average HR tended to be higher in EX+HEAT than EX+TEMP, expressed in both absolute HR (by  $4 \pm 6$  b/min; 95% CI: 0 - 8 b/min;  $p=0.056$ ) and relative to HR max (by  $2 \pm 3\%$ ; 0 - 4%;  $p=0.052$ ). RPE was similar between regimes ( $15 \pm 1$ ; vs  $15 \pm 0$ ;  $p=0.48$ ) and equivalent over weeks ( $p=0.08$ ). VO<sub>2</sub>max increased while HRmax decreased across both regimes (by  $13 \pm 6$  vs.  $18 \pm 14\%$ ;  $p<0.001$ ); and  $5 \pm 3$  vs.  $2 \pm 5$  b/min;  $p=0.003$ ), and by similar extents between regimes (CI: -15 - 5%; and -7 - 0 b/min). Resting mean arterial pressure was reduced in both regimes (by  $7 \pm 5$  and  $10 \pm 6$  mm Hg;  $p<0.0001$ ), to a similar extent (CI: -1 - 8 mm Hg). On average, HEAT+EX caused larger increases than TEMP+EX in fat free mass (by 1%; CI: 0 - 2%;  $p=0.03$ ), total body water volume (by 1%; 0 - 2%;  $p=0.03$ ), and resting metabolic rate (by 1%; 0 - 2%;  $p=0.03$ ). **Discussion** Despite lower absolute work rates required to elicit a target HR during HIIT performed in the heat, cardio-respiratory and functional adaptations were equivalent to those obtained in a temperate environment, whereas body composition adaptations were slightly larger. Elevated tissue temperatures per se in the face of lower work performed may have been responsible (Staib et al. 2007, Yoshihara et al. 2012). **References** Staib JL, Quindry JC, French JP, Criswell DS, Powers, SK. (2007). *Am J Physiol Regul Integr Comp Physiol* 292, 432-439. Weston KS, Wisloff U, Coombes JS. (2014). *Br J Sports Med* 48, 1227-1234. Yoshihara T, Naito H, Kakigi R, et al. (2012). *Acta Physiol (Oxf)* 20, 416-426. Contact Ashley.Akerman@otago.ac.nz

## THE EFFECT OF MENTAL FATIGUE ON PHYSICAL PERFORMANCE, A SYSTEMATIC REVIEW.

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1 Department of Human Physiology, Vrije Universiteit Brussel, Brussels, Belgium 2 Endurance research group, School of Sport and Exercise Sciences, University of Kent at Medway, Chatham Maritime, Kent ME4 4Ag, UK 3 School of Public Health, Tropical Medicine and Rehabilitation Sciences, James Cook University, Queensland, Australia 4 FWO, Belgium **Introduction** Recently it has been shown that both forms of fatigue, mental and physical, affect one another (Marcora et al., 2009). The rather limited amount of studies available show that mentally fatigued individuals have a decreased physical performance capacity. **Objective** To evaluate the existing literature about the influence of mental fatigue on physical performance. **Data Sources** We searched the electronic databases PubMed and Web of Knowledge (up until December 2014). The search terms we used were 'mental fatigue [MeSH]' and 'cognitive fatigue', in combination with 'exercise [MeSH]' and 'athletic performance [MeSH]'. **Study Selection** Randomized crossover designs investigating the effects of mental fatigue on physical performance in healthy humans were included in this systematic review. Outcomes concerning physical performance and possible peripheral and central mechanisms underlying the effect of mental fatigue were included. **Results** Nine studies of high quality (>67% [Kmet et al., 2004]) were included, all used a randomized crossover design in an athletic adult population. The mean of subjects participating in the study was ( $16 \pm 9$ ). Five studies investigated the effects of mental fatigue on aerobic performance, the other 4 on anaerobic performance. The general finding was a decreased aerobic performance, while anaerobic performance seems not to be affected. The decrease in aerobic performance was accompanied by an increase in ratings of perceived exertion (RPE), while cardi-

orespiratory and musculo-energetic mechanisms were not altered during physical performance due to mental fatigue. Conclusion Although until now only 9 studies could be included, it seems that mental fatigue has a negative effect on prolonged aerobic performance. Anaerobic performances (maximal muscle activation, voluntary maximal strength, explosive power and anaerobic work capacity) are not affected. Mental fatigue decreases aerobic performance through a higher RPE, rather than through cardiorespiratory and musculo-energetic mechanisms. However additional research has to be done in order to determine through which mechanism RPE negatively affects physical performance. References Kmet et al. 2004. Standard quality assessment criteria for evaluating primary research papers. Alberta Heritage Foundation for Medical Research. Marcora et al 2009. J Appl Physiol (1985), 106, 857-64. Contact Jeroen Van Cutsem Email: jvcutsem@vub.ac.be

### ARE MOTOR-RELATED ELECTRO-CORTICAL MARKERS MODULATED BY AN ACUTE ENDURANCE EXERCISE?

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**Introduction** Among the methods used to investigate the effect of exercise on the brain, the electroencephalography (EEG) seems to be a promising technique in sport sciences (Thompson et al. 2008). Voluntary movements are preceded by a low frequency brain activity that occurs about 1.5 seconds before movement onset. This movement-related cortical potential (MRCP) could be considered as a direct neurophysiological marker of central motor command (Berchicci et al. 2013). The purpose of this study is to investigate the effects of two endurance exercises with moderate and high intensities on the preparatory phase of voluntary movements using the surface EEG. **Methods** Sixteen trained athletes performed two successive exercises on a cycle ergometer consisting in a 30 minutes submaximal exercise at 60% of maximal aerobic power, and a 10 kilometres all-out time trial. Before (PRE), between (MID) and after (POST) the two sessions of exercise, surface EEG was recorded during 60 self-paced leg extensions. The central MRCPs were segmented and averaged into non-overlapping epochs from 2500 ms before and 500 ms after the leg movement onset. Two components before movement were used for the statistical analyses: the readiness potential (RP: -1500 ms to -1000 ms) and the motor potential (MP: -100 ms to peak amplitude). Maximal voluntary contraction (MVC), voluntary activation level (VAL) and the potentiated doublet force were also quantified using the percutaneous neuromuscular stimulation method. **Results** The analyses revealed that MVC decreases between PRE-MID (10.8%) and MID-POST (10.1%). A reduction in the VAL between PRE-MID (6.3%) and MID-POST (4.8%) occurs and was accompanied by a reduction in the potentiated doublet force between PRE-MID (6.4%). The MRCP mean negativity amplitudes during RP decreases both between PRE-MID (+1.09 $\mu$ V) and PRE-POST (+1.33 $\mu$ V), whereas MP shows a decrease only between PRE-POST (+3.1 $\mu$ V) sessions (all  $p$ s<0.05). **Discussion** The results show that an endurance exercise induces a reduction in the MRCP amplitude associated with a significant reduction in force production. While an increase in the negativity has been shown to compensate peripheral fatigue (Dirnberger et al. 2004, Schillings et al. 2006), conversely a decrease seems to be indicative of a reduction in synaptic activity (Deecke, 1996) and a reduction in central motor command. The intensity-dependant reduction of the MRCP components deserves further investigations. **References** Berchicci M., Menotti F. et al. (2013). *Front. Hum. Neurosci.* Deecke, L. (1996). *Cognitive Brain. Reserach.* Dirnberger G., Duregger C. et al. (2004). *Brain Res.* Schillings ML., Kalkman JS. et al. (2006). *Euro J Appl. Physiol.* Thompson T., Steffert T. et al. (2008). *Methods.* Contact jeroen.spring@unil.ch

## Mini-Orals

### MO-PM21 Physiology: Energy metabolism

#### THE METABOLIC COST OF CYCLING AT 0 W COMPARED TO PHYSIOLOGICALLY ESTIMATED INTERNAL

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**INTRODUCTION** The cost of unloaded cycling, that is, cycling at 0 W external mechanical power (EP), ought to be equivalent to the metabolic cost of the rate of mechanical work that is performed only to move the limbs against gravitational and inertial forces – the internal mechanical power (IP). A number of studies have concluded that this might not be the case, including Gaesser and Brooks<sup>2</sup>, who reported that the metabolic cost measured during unloaded cycling “deviated significantly” from the linear relationship between energy expenditure and other magnitudes of EP at a number of cadences. The aim of this study was to compare the cost of unloaded cycling to the cost of IP determined using a physiological model. **METHOD** Ten elite cyclists performed 0 (no chain), 100, 200 and 300 W on a wind-braked cycle ergometer at 80 and 110 rev · min<sup>-1</sup>. Oxygen consumption was converted to metabolic power (MP), and IP was calculated as the intercept of the MP-EP relationship minus the resting metabolic rate<sup>3</sup>. **RESULTS** The metabolic cost of unloaded pedalling (0 W) was significantly greater than IP at both cadences (80 rev · min<sup>-1</sup>: 222 ± 8 J · s<sup>-1</sup> vs 105 ± 14 J · s<sup>-1</sup>,  $P < 0.001$ ; 110 rev · min<sup>-1</sup>: 367 ± 12 J · s<sup>-1</sup> vs 212 ± 16 J · s<sup>-1</sup>,  $P < 0.001$ ). The slopes of the MP-EP relationships at 80 and 110 rev · min<sup>-1</sup> were significantly greater when the MP at 0 W was included compared to when it was not. There were, however, strong linear relationships at both cadences ( $R^2 = 0.997$  and  $R^2 = 0.991$  at 80 and 110 rev · min<sup>-1</sup>, respectively) with the inclusion of MP at 0 W. **DISCUSSION** The mechanical equivalent of the difference between MP at 0 W and IP is approximately 29 W. This demonstrates the need for careful consideration when choosing a physiological model for determining the metabolic cost of IP – whether predicted through extrapolation or by direct measurement of unloaded cycling. Interestingly, the strong linearity between MP and EP in this group of elite cyclists suggested they might not have encountered coordination difficulties during unloaded cycling, which had been proposed previously<sup>1</sup>, lending support to the direct measurement approach to IP. **REFERENCES** 1Foss, O., & Hallén, J. (2004). The most economical cadence increases with increasing workload. *Eur J Appl Physiol.* 92(4-5): 443-451. 2Gaesser, G. & Brooks, G. (1975). Muscular efficiency during steady-rate exercise: effects of speed and work rate. *J Appl Physiol.* 38(6): 1132-1139. 3Francescato, M. et al. (1995). Oxygen cost of internal work during cycling. *Eur J Appl Physiol Occup Phys.* 72(1/2): 51-57.



**HIGH INTENSITY INTERVAL TRAINING IN NON-ALCOHOLIC ESTATOHEPATITIS: A CASE REPORT.**

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**Introduction:** Non-alcoholic esteatohepatitis (NASHD) is a chronic hepatic disease of unknown etiology, characterized by the anomalous deposition of triglycerides in the liver. The role of exercise as a therapeutic agent in this disease is under discussion. Given the effect of high intensity interval training (HIIT) on lipid mobilization and metabolism, we studied the effects of 8 weeks of HIIT in an adult male diagnosed of NASHD. **Methods:** After signing an informed consent, a recreative physically active 40 years old Caucasian male, diagnosed 18 years before of NASHD, performed an 8 weeks HIIT program. During the first 4 weeks, in addition to the HIIT the subject performed a two hours match of paddel-tennis per week. However, during the resting 4 weeks, the subject only performed the HIIT, without any other recreational exercise. An indirect calorimetry before and after a typical HIIT session was performed, to analyze the effects on lipid oxidation. Before (PRE), and after 4 and 8 weeks of HIIT program (IM and POST, respectively), glycemia, lipidic profile and hepatic enzymes were obtained by blood analysis. Additionally, anthropometries and maximal stress tests were performed both PRE and POST intervention. During the intervention period the subject followed an individualized diet. **Results:** At rest, 35% of Kcal were obtained from fat. For the 15 hours after a single HIIT session, fat represented up to 70% of Kcal production at rest. This value returned to baseline by 23 hours after the session. No differences were observed either at the cardiorespiratory fitness or at the anthropometry after the HIIT program. In the IM blood analysis, fasting glycemia and gamma-glutamyl transpeptidase (GGT) tended to decrease (97 vs 95,5 mg•dL<sup>-1</sup>, 229 vs 179,5, U•L<sup>-1</sup> respectively) while circulating triglycerides tended to increase (308 vs 409,5 mg•dL<sup>-1</sup>). At the POST blood analysis, fasting glycemia still showed a tendency to be reduced (95 mg•dL<sup>-1</sup>), while GGT and circulating triglycerides tended to increase in comparison with the IM evaluation (240 U•L<sup>-1</sup> and 360 mg•dL<sup>-1</sup>). **Discussion:** Despite being an isolated observation, our data suggest that HIIT may contribute to improve the hepatic inflammation seen in NASHD. The removal of the abnormal hepatic deposition of triglycerides, and the increased fat utilization at rest, can be hypothesized as the underlying mechanisms.

**AEROBIC CONTRIBUTION TO THE WINGATE TEST PERFORMANCE: EFFECTS OF A HIGH BRAKING FORCE**

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**Introduction** Controversial results have been found about the effects of circadian rhythms on the Wingate test (WT) (Reilly and Down 1992; Souissi et al. 2004). Although WT has been used extensively as an index of anaerobic performance, the rate of aerobic energy contribution is considerable and depends on subjects' anaerobic level (Granier et al., 1995). Therefore, the aerobic contribution to the total work may explain the discrepancies between studies. Moreover, the load traditionally used is likely much low to maximize work output (Driss and Vandewalle, 2013). Our study examined the effects of time of day on WT performance and aerobic contribution to the total amount of energy released during WT using a high braking force. **Methods** 11 active male participated in the study (25±3 years, 183±8 cm, 83±9 kg). They performed two WT tests sessions at 7:30 and 18:30h. The braking force (Monark 894E cycle ergometer) was 11.5% of body mass (11.5% BM). During each test, the expired gasses were measured using a Cosmed K4b<sup>2</sup> analyzer. The net O<sub>2</sub> uptake (VO<sub>2net</sub>) was derived by subtracting the VO<sub>2</sub> at rest from the VO<sub>2</sub> consumed during the test. VO<sub>2net</sub> was converted to work by a factor of 20.92 kJ.l.O<sub>2</sub><sup>-1</sup>. The aerobic contribution (AC%) was calculated from the ratio of aerobic work (WO<sub>2</sub>) to the total work (Wtot). These parameters were averaged over 5-s intervals. **Results** Two-way ANOVA test for repeated measures (time of day x time interval) revealed a significant effect of time interval on Wtot (p<.001). Post hoc test showed that Wtot decreased after 10 s with morning and evening confounded. However, no significant effects of time of day, and time of day x time interval were observed on Wtot. Significant effect of time of day and time interval were observed on WO<sub>2</sub> (p=.018 and p<.001, respectively). A significant interaction effect of time of day x time interval was noted on this parameter (p<.05). Post hoc test showed that WO<sub>2</sub> increased during the test and was greater in the evening compared to the morning at the second half of the test. Similar results were observed for AC (%) (time of day: p=.049, time interval: p<.001, and time of day x time interval: p=.011). **Discussion** Aerobic contribution was greater at the evening compared to the morning. In accordance with Reilly and Down (1992), our results showed no significant effect of daytime variation on total work despite that the work at the first 10-s was greater in the evening by comparison to the morning (p<.05). The use of a high braking force in the present study (11.5% BM vs. 7.5% or 8.7% BM in the literature) could explain this finding. To elucidate the mechanisms responsible of diurnal variations during WT, optimal braking force should be used. **References** Driss T, Vandewalle H (2013). *BioMed Res Int*, 2013, 1-40. Granier P, Mercier B, Mercier J, Anselme F, Préfaut C (1995). *Eur J Appl Physiol*, 70, 58-65. Reilly T, Down A (1992). *J Sports Medicine and Physical Fitness*, 32, 343-347. Souissi N, Gauthier A, Sesboué B, Larue J, Davenne D (2004). *Int J Sports Med*, 25, 14-19. Contact tarak.driss@u-paris10.fr

**EXPRESSION OF IRISIN IN SERUM AND SKELETAL MUSCLE WERE INCREASED FOLLOWING RESISTANCE TRAINING IN AGING MICE**

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**Introduction** Irisin, a novel myokine as a peptide recently identified, mediates some of the beneficial effects of exercise on fat metabolism by a process named adipocyte browning through inducing uncoupling protein 1. In the present study, we investigate the effect of resistance training on irisin expression in serum and skeletal muscle with improvement of muscle strength and function in aging mice. **Methods** Nineteen months old male C57BL/6 mice were randomly assigned to two groups, old Control group (Old-Con) and old Resistance exercise group (Old-Ex). For exercise group, progressive resistance ladder climbing exercise with tail weight was performed 3 days per week for 12 weeks. Whole body animal dual energy x-ray absorptiometry (DXA) modulation was used to measure body composition after training program. Every two weeks, grip-strength was measured by using Grip Strength Meter. Irisin expressions were evaluated in circulating level and skeletal muscle using ELISA. **Results** There was no significant difference in body weight, fat mass and lean mass between Old-Con and Old-Ex. Grip strength of old mice was significantly increased (14.85%, p=0.02) in Old-Ex compared to Old-Con. The significant improvement (16.34%, p=0.03) of muscle quality following resistance training was found in Old-Ex compared to Old-Con. In circulating level, irisin protein in serum of Old-Ex was higher (p=0.02) compared to Old-Con. The significant increase of irisin protein was found in soleus muscle of Old-Ex compared to Old-Con, whereas, there are no significant changes in extensor digitorum longus, tibialis anterior, and gastrocnemius muscles. **Discussion** Exercise induced irisin secretion by contracting skeletal muscles, which could have evolved from shivering-related muscle contraction, might be a potential target of therapies designed to optimize weight

control and metabolic profile (Lee et al., 2014). Hur et al., (2012) reported that circulating irisin negatively related with age, insulin, cholesterol, and adiponectin levels, indicating a possible compensatory role of irisin in age-related metabolic regulation. Based on our results and the previous reports focusing important role of irisin in aging, resistant training might be an efficient intervention for not only increase the circulating irisin levels, but also prevent the age-related decline of muscle strength. References Lee P, Linderman JD, Smith S, Brychta RJ, Wang J, Idelson C, Perron RM, Werner CD, Phan GQ, Kammula US, Kebebew E, Pacak K, Chen KY, Celi FS. (2014). *Cell Metab*, 19(2), 302-309. Huh JY, Panagiotou G, Mougios V, Brinkoetter M, Vamvini MT, Schneider BE, Manizoros CS. (2012). *Metabolism*, 61(12), 1725-1738. Contact songw3@snu.ac.kr

### LESS PRONOUNCED RESPONSE TO EXERCISE IN HEALTHY RELATIVES TO TYPE 2 DIABETICS COMPARED TO CONTROLS

Ekman, C., Elgzyri, T., Ström, K., Almgren, P., Parikh, H., Dekker Nitert, M., Rönn, T., Manderson Koivula, F., Ling, C., Tornberg, Å.B., Wollmer, P., Eriksson, K.F., Groop, L., Hansson, O.

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Healthy first-degree relatives with heredity of type 2 diabetes (FH+) have been shown to have metabolic inflexibility when compared to subjects without heredity for diabetes (FH-). In this study, we investigate whether FH+ individuals respond differently to an exercise intervention compared to FH-. 16 FH+ and 19 FH- insulin sensitive men similar in age, VO<sub>2</sub>peak and BMI completed an exercise intervention in which the participants were monitored with heart rate measurements during exercise for 7 months. Before and after the exercise intervention, the participants underwent a physical examination, tests for oral glucose tolerance and maximal exercise capacity. Muscle biopsies were taken for gene expression analysis using microarrays. The volunteers participated in on average 39 training sessions during the intervention and spent on average 18.8 MJ on exercise. VO<sub>2</sub>peak/kg increased by 14%, the participants lost 1.2 kg of weight and 3 cm waist circumference. Using regression analysis, exercise volume had significant effect on VO<sub>2</sub>peak, weight and waist circumference in the FH- group, but not in the FH+ group. After exercise, expression of genes involved in metabolism, oxidative phosphorylation and cellular respiration increased more in the FH- group, compared to the FH+ group. This indicates that healthy, insulin sensitive FH+ and FH- participants with similar age, VO<sub>2</sub>peak and BMI respond differently to an exercise intervention. The FH+ background might limit the muscle adaptation to exercise, which may contribute to the increased susceptibility to type 2 diabetes in FH+ individuals. Do not insert authors here

### COMPARISON OF CARBOHYDRATE AND FAT OXIDATION AFTER MAXIMAL INCREMENTAL CYCLE ERGOMETER EXERCISE TESTING IN OBESE AND LEAN ADULTS

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Introduction Measuring carbohydrate and fat oxidation (carb and fat ox) terminates in most testing protocols after reaching the final work load. There is evidence that energy metabolism is increased even during post-exercise conditions (Jamurtas et al., 2004). No data exists comparing acute post exercise metabolic response following maximal exhaustion in healthy and obese adults. The aim of this study was to analyze differences in post exercise carb and fat ox in obese and lean adults during a continuous 3 min active and 3 min passive recovery after maximal incremental cycle ergometer exercise testing (ICE). Methods 8 sedentary obese (O) (BMI: 43.9±5.4 kg·m<sup>-2</sup>, 42.6±13.0 yrs, 5 female/3 male) and 8 age- and sex-matched sedentary lean adults (C) (BMI: 22.4±2.1 kg·m<sup>-2</sup>) performed an ICE, after overnight fasting. Carb and fat ox was calculated by indirect calorimetry and given as mg·kg bodyweight<sup>-1</sup>·min<sup>-1</sup> (Peronnet et al., 1991). Gas exchange was measured until maximal exhaustion and during a 3 min active and 3 min passive recovery. Delta carb ox was calculated for the time-dependent reduction of carb ox. Calculations were performed with paired t-test or Wilcoxon signed rank test (α=0.05). Results No detectable fat oxidation was observed during the whole 6min post ICE period. Comparison of mean values for each of the six minutes between groups resulted in a significant higher carb ox in controls during the first 3 minutes (1 min: 57.53±19.74 vs 28.61±15.27, p<0.000; 2 min: 36.43±14.86 vs 22.37±12.01, p=0.019; 3 min: 23.24±11.70 vs 15.76±7.54, p=0.023) and no significant difference in the last 3 min. After min 1, 2 and 3 delta carb ox was significantly different between groups (1min O:6.23±3.59 vs C:21.10±10.60, p=0.002; 2min O:6.62±4.74 vs C:13.19±4.77, p=0.04; 3min O: 3.34±3.58 vs C:7.82±4.28, p=0.045). Relative exercise capacity was 1.2±0.50 in obese and 3.1±0.7 W·kg<sup>-1</sup> in controls. Discussion Higher maximal intensity results in higher carbohydrate oxidation, explaining the investigated difference between controls and obese subjects directly after ICE. Although these differences could be explained, in respect to the time course of carb ox during the first 3 min of active recovery, controls seem to have a faster physiological regulation. During the 3 min passive recovery same reactions were found in both groups, indicating no physiological differences. Reference Jamurtas A Z, Koutedakis Y, Paschalis V, Tofas T, Yfanti C, Tsiokanos A, Koukoulis G, Kouretas D, Loupos D.(2004). *Eur J Appl Physiol*, 92 (4-5), 393–398. Peronnet F, Massicotte D.(1991). *Can J Sport Sci*, 16 (1), 23–29. Contact kratzens@uni-potsdam.de

## Mini-Orals

### MO-PM23 Physiology: Mixed session

### COMPARISON OF CARBOHYDRATE AND FAT OXIDATION RATES DURING MAXIMAL INCREMENTAL CYCLE ERGOMETER EXERCISE TESTING IN OBESE AND LEAN ADULTS

Braun, M.1, Moser, O.1, Otto, C.1, Kratzenstein, S.1, Ruessmann, A.1, Messerschmidt, J.1,2, Marusch, F.1,2, Mayer, F.1

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Introduction There is evidence that lipid oxidation is decreased in skeletal muscles in obese individuals during submaximal exercise as well as at rest. In addition accumulation of lipids within muscles could result in insulin resistance, a known site effect of obesity and associated with a variety of health-related risks (Houmard, 2008). The aim of this study was to compare carbohydrate and fat oxidation during maximal incremental cycle ergometer exercise testing between obese and lean controls. Methods Eight sedentary obese (BMI: 43.7 ± 5.5 kg·m<sup>-2</sup>, 42.6 ± 13.0 years, 6 female/2 male) and eight age- and sex-matched sedentary lean controls (BMI: 22.5 ± 2.2 kg·m<sup>-2</sup>, 43.0 ± 13.4 years) performed a maximal incremental cycle ergometer test after overnight fasting to determine the first (LTP1) and second lactate

turn point (LTP2) (Tschakert et al., 2015). Gas exchange variables were measured continuously and blood lactate concentration was determined at rest and at the end of every workload step. Rates of carbohydrate and fat oxidation were calculated using indirect calorimetry (Péronnet and Maissicotte, 1991). Data analysis was conducted through paired t-test or Wilcoxon signed-rank test ( $\alpha = 0.05$ ). Results At LTP1 lean controls used significantly ( $p < 0.05$ ) more energy from fat oxidation than obese adults ( $7.08 \pm 3.91$  vs  $3.37 \pm 2.11$  mg•kg bodyweight (BW)•l•min<sup>-1</sup>) while no difference ( $p > 0.05$ ) for carbohydrate oxidation. Carbohydrate oxidation rates were significantly higher in lean controls compared to obese adults at LTP2 ( $33.05 \pm 13.08$  vs  $14.78 \pm 6.53$  mg•kg BW•l•min<sup>-1</sup>) ( $p < 0.001$ ) and at Pmax ( $61.96 \pm 25.19$  vs  $27.63 \pm 15.68$  mg•kg BW•l•min<sup>-1</sup>) ( $p < 0.001$ ). Obese adults produced more lactate at rest, LTP1 and LTP2 but less at Pmax than lean adults with no significant differences ( $p > 0.05$ ) detected between groups. Discussion Sedentary obese adults, compared to age- and sex-matched lean controls, showed a shift in the balance of substrate oxidation. Both, carbohydrate and fat oxidation at different exercise intensities are significantly impaired in obese in comparison to lean adults. Out of results an individualized exercise prescription in combination with pre-exercise dietary modifications should be recommended for obese people. References Houmard JA. (2008). *Am J Physiol Regul Integr Comp Physiol*, 294(4), 1111-1116. Tschakert G, Kroepfl J, Mueller A, Moser O, Groeschl W, Hofmann P. (2015). *J Sports Sci Med*, 14, 29-36. Péronnet F, Maissicotte D. (1991). *Can J Sport Sci*, 16, 23-29. Contact Monique Braun mobraun@unipotsdam.de

### EFFECTS OF HYDROGEN-RICH WATER INTAKE ON WORK RATE AT LACTATE THRESHOLD

Yoshimura, S., Ichikawa, M., Kose, Y., Kawasaki, K., Nishimura, S., Ito, A., Nakashima, S., Kiyonaga, A., Tanaka, H., Higaki, Y.

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Introduction Oxidative stress occurs when the production of free radical moieties exceeds the antioxidant capacity. Recent studies have revealed that molecular hydrogen can ameliorate diseases associated with oxidative stress. Further, hydrogen-rich water (HW) intake can prevent an increase in blood lactate, an index of muscle fatigue, without significant changes in blood oxidative injury markers. However, the effect of HW intake of performance in athletes remain unclear. Thus, we examined the effect of HW intake on work rate using the lactate threshold (LT) as an index of endurance performance. Methods This study was a randomized crossover study. Subjects were fifteen healthy males ( $23.2 \pm 2.2$  years,  $170.7 \pm 6.5$  cm,  $65.6 \pm 4.7$  kg). Subjects consumed a packet of HW or placebo water (PW) followed by 30 min rest. Subjects then underwent an incremental exercise test using a bicycle ergometer. The work rate was initially set to 10 W of 60 rpm for the first 4 min of warm-up, and was then increased by 15 W/min during the ramp test. Blood lactate was measured before, during (every 1 min), and after the test (1, 3, 5, and 10 min). Respiratory data, heart rate (HR), and rating of perceived exertion (RPE) were measured during the test. The LT was determined for each subject based on visual inspection, and the average was determined according to the estimations of five experts who were blinded to the conditions. Results The work rate at LT during the test was significantly higher in HW intake than that in PW intake ( $103.6 \pm 14.0$  vs  $97.4 \pm 12.2$  W;  $p < 0.05$ ). There were no differences in oxygen consumption, HR, or RPE at LT between the conditions. Further, maximal oxygen consumption and maximal lactate concentration did not change in either condition. Discussion Despite an improved work rate at LT observed with HW intake, the mechanisms that mediate this important phenomenon remain unclear. It is possible that lactate production in working skeletal muscle during exercise may be reduced by HW intake. Alternatively, increased uptake of lactate into mitochondria following HW intake may be associated with an improved work rate at LT. However, although we cannot rule out a role for mitochondrial function in HW intake, we consider this unlikely as no effects of HW intake on blood lactate were observed at rest. These data suggest that HW intake may improve endurance performance. References Ohsawa I et al. (2007). *Nat Med*, 13, 688-694. Contact dreamaffectionately@yahoo.co.jp

### REPEATABILITY OF THE DEPLETION OF MUSCLE GLYCOGEN AFTER PROLONGED AND HIGH INTENSITY EXERCISE

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Muscle glycogen is the major source of substrate in both prolonged and high-intensity exercise tests, and the depletion of muscle glycogen could lead to fatigue and the limitation of exercise performance. Although muscle glycogen was decreased by various exercise tests in previous studies, the repeatability was little reported. In our previous study, the decrement rates of muscle glycogen after short-duration, high-intensity exercise tests were different between the first and second tests (unpublished data). Purpose: The aim of this study was to investigate the repeatability of the decrement rate of muscle glycogen after exhaustive exercise tests. Methods: After the peak of oxygen uptake (VO<sub>2peak</sub>) of eight endurance-trained male subjects (age,  $20 \pm 1$  yr.) was assessed, the same exercise tests were completed on three separate occasions. The exercise protocols were 60-min cycling exercise at 70% of VO<sub>2peak</sub>, immediately followed by high-intensity intermittent exercise (five 1-min exercises at 100% of VO<sub>2peak</sub> separated by 4-min exercises at 35% of VO<sub>2peak</sub>) and one all-out exercise at 100% of VO<sub>2peak</sub> to exhaustion. Muscle glycogen from the vastus lateralis was non-invasively evaluated by carbon-13 magnetic resonance spectroscopy (13C-MRS) before and immediately after the tests. Blood glucose and lactate concentrations were measured at the fingertip every 15 min during 60-min exercise and immediately after the end of all-out tests. Results: The duration of all-out tests at the first, second, and third occasions were  $163 \pm 86$  s,  $191 \pm 144$  s, and  $202 \pm 142$  s, respectively. There was no significant difference among the three tests. The blood glucose and lactate concentration were not significantly different among three occasions. Muscle glycogen concentrations before and after tests were 72.9 and 22.4 mM, 76.4 and 21.7 mM, and 81.4 and 29.7 mM, respectively. The decrement rate of muscle glycogen in one subject was low ( $35.7 \pm 15.4\%$ ), and the intra-subject coefficient of variation (CV) was 43.2%. Except the subject, the decrement rates of muscle glycogen at the first, second, and third occasions were  $77.8 \pm 5.4\%$ ,  $74.9 \pm 7.7\%$ , and  $72.1 \pm 10.2\%$ , respectively (N.S.). The intra-subject CV of these seven subjects was  $5.6 \pm 5.0\%$  (the range was from 0.9% to 15.5%), and the inter-subjects CV was 10.7%. Additionally, the percent change of all-out test duration between the first and third occasions was not significantly related to the change of decrement rate of muscle glycogen. Conclusion: Muscle glycogen after this exhaustive exercise tests decreased largely in seven of the eight subjects and the high repeatability was achieved despite improving exercise performance. Although further studies are needed to elucidate the exceptional results of one subject, our results imply that the exercise protocol could be effective to decrease the glycogen of main working muscles.

**DOES STRETCHING HAVE A FACILITATIVE EFFECT ON RECOVERY FROM ACUTE STRESS RESPONSE?**

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Does Stretching Have a Facilitative Effect on Recovery from Acute Stress Response? University of Tsukuba (Tsukuba, Japan) Introduction There are many psychological stressors in modern society. Though acute stress responses (ASR), such as temporal cortisol elevation via HPA axis activation, to those stressors are essential for maintaining homeostasis, failure to shut off this response and a chronic increase in cortisol could lead to serious conditions such as depression. Thus, it is of great importance to cope with psychological stress effectively. Among several stress release therapies, static stretching (SS) is a leading candidate for facilitating recovery from ASR. A recent study revealed that SS increases parasympathetic activity, which plays an important role in shutting off acute stress response (Pawlowlo et al., 2011). Thus, SS could cause muscle relaxation and facilitate recovery from ASR. To test this, we examined whether SS improved the recovery rate from an ASR induced by a mental stress task. Method Nineteen young, healthy male subjects were randomly divided into stretching (STR, n=10) and control (CTL, n=9) groups. All subjects performed a psychosocial stress task, the Trier Social Stress Test (TSST), consisting of a public speech and an arithmetic task. Twenty minutes after the TSST, the STR did 10 minutes of SS, and the CTL rested for 10 minutes. Saliva was collected before and immediately after the TSST, and every 10 minutes until 50 minutes after the TSST. Salivary cortisol (sC) was analysed with ELISA. In order to confirm the effect of SS on muscle relaxation, muscle hardness in the trapezius were measured with a muscle hardness meter, which evaluates the repulsive force of muscle, before the TSST and after SS. Six subjects (STR: 2, CTL: 4) did not have an increase in sC levels after the TSST and were excluded from this analysis. Results In both groups, sC concentrations were significantly increased after the TSST. Contrary to expectation, SS didn't change muscle hardness in the STR and recovery rates for sC levels after the TSST were no difference between both groups. However, when only subjects with a habit of SS ( $\geq 1$  time per week; n=5) were selected, muscle hardness in the left trapezius was significantly decreased after SS and recovery rates for sC levels after TSST were higher compare to the CTL. Discussion Increased sC levels after the TSST indicate that this mental task could induce a ASR. We found for the first time that SS facilitates the recovery rate for elevated sC levels only in subjects with a habit of SS. Because an significant effect of SS on muscle relaxation could only be seen in subjects with a habit of SS, it is possible that muscle relaxation by SS increases parasympathetic activity and decreases cortisol secretion due to exposure to psychological stress. These results suggest that SS effective for muscle relaxation has beneficial effects on recovery from ASR.

**IS CORTISOL CONCENTRATION DEPENDED ON INTENSITY TRAINING?**

García-Valverde, A., Aracil, A., Fernandez-Fernandez, J., Marc-Hernández, A., Martínez-Cantó, A., Mateo-Cubo, F., Pastor, D., Sabido, R., Sánchez-Martos, M.A., Sarabia, J.M., Moya, M.

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Introduction The biochemistry control of training with physiological markers, such as salivary cortisol hormone (Crewther et al., 2013), seems to be useful to athletes control of physical stress loads, so that glucocorticoid secretion has been linked to stress response of physical exercise (Kraemer & Ratamess, 2005). Several authors have compared the salivary cortisol's concentration (SCC) produced on training with higher and lower intensities, and they found controversial results (McCaulley et al., 2009; McGuigan, Egan, & Foster, 2004; Stokes, Gilbert, Hall, Andrews, & Thompson, 2013). Our purpose were to know the salivary cortisol response after modifying intensity level training. Methodology Fifteen untrained men took part in this study. Participants were randomly divided into two groups in order to carry out tests, twice per week, during seven weeks. Each group completed a power bench press throw test which consisted of completing 6 series until they there were two consecutive repetitions below a 10% from the maximum value recorded in sets, with 5 minutes recovery between sets. The intensity per week was counterbalanced between both groups. Before power test a sample of saliva was collected and then the subjects performed a standard warm up. Another sample of saliva was collected immediately after the daily protocol. Moreover, the volume training was standardize according to maintenance mechanical power principle and acute fatigue was monitored with lose power. Results Peak power was showed between 40%-70% of 1RM. Moreover, optimal's repetitions decreased significantly twice {30%-40%RM [F(1,13)=6.618; p=0,023;  $\eta^2=0,337$ ]; 50%-60%RM [F(1,13)=6.877; p=0,021;  $\eta^2=0,346$ ]} A significant decrease in SCC for all intensities was showed {30%RM [F(1,14)=33.156; p=0.000;  $\eta^2=0.703$ ]; 60%RM [F(1,14)=18.919; p=0.001;  $\eta^2=0.575$ ]; 90%RM[F(1,14)=19.432; p=0.001;  $\eta^2=0.581$ ]} Conclusion Power data obtained on this study are similar to previous reports at the literature (Cronin, McNair, & Marshall, 2001; Stock, Beck, Defreitas, & Dillon, 2010) In the other hand, SCC is influenced by using different intensities in the training of power under the principle of maintenance of mechanical power. Although, the SCC seems to be sensitive to the intensity, as showed by a similar decrease (25-35%) in all RM percentages, SCC did not show differences between percentages.

**HORMONAL RESPONSES TO SPRINT EXERCISES UNDER DIFFERENT HYPOXIC CONDITIONS**

Kon, M., Nakagaki, K., Ebi, Y., Nishiyama, T., Russell, A.

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Introduction: Sprint exercise (Stokes et al., 2013) and hypoxic stimulus during exercise (Kon et al., 2010, Sutton, 1977) are potent factors affecting hormonal responses. However, the effects of different hypoxic levels on hormonal responses during sprint exercise are not known. Here, we examined the effect of different hypoxic conditions on hormonal responses during sprint exercise. Methods: Seven male subjects participated in three experimental trials: 1) sprint exercise under normoxia (NSE), 2) sprint exercise under moderate normobaric hypoxia (16.4% oxygen) (HSE 16.4), and 3) sprint exercise under severe normobaric hypoxia (13.6% oxygen) (HSE 13.6). The sprint exercise consisted of four 30 s all-out cycling bouts with 4-min rest between bouts. Growth hormone (GH), epinephrine (E), norepinephrine (NE), and insulin concentrations were measured before exercised under normoxic and hypoxic conditions, 15 min after exposure to hypoxia, and at 0, 15, 30, 60, 120, and 180 min after the exercise in normoxia and hypoxia. Results: GH, E, NE, and insulin levels significantly increased after all three exercise trials ( $P < 0.05$ ). The area under the curve (AUC) for GH was significantly higher in the HSE 13.6 trial than in the NSE and HSE 16.4 trials ( $P < 0.05$ ). Discussion: Resistance exercise performed during acute severe hypoxia (13% oxygen) causes a larger increase in GH concentrations than that in normoxia (Kon et al., 2010). Additionally, submaximal endurance exercise performed under severe hypoxic conditions (4550 m above sea level; approx. 12% oxygen) increases circulating GH level greater than exercise performed under normoxic condition (Sutton, 1977). In contrast, resistance exercise performed under moderate hypoxia (15% oxygen) or normoxia caused similar levels of GH secretion (Ho et al., 2014). Similarly, submaximal endurance exercise performed under moderate hypoxia (2000 m above sea level; approx. 16.5% oxygen) or normoxia elicited similar GH response (Katayama et al., 2010). Severe hypoxia may be an important factor for the enhancement of GH response to all-out sprint exercise. References Ho JY, Huang TY, Chien YC,

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### HIGH-PROTEIN DIETS INDUCE RENAL OXIDATIVE STRESS IN RATS PERFORMING A HIGH INTENSITY EXERCISE

Camiletti-Moirón, D., Aparicio, V.A., Nebot, E., Medina, G., Martínez, R., Kapravelou, G., Andrade, A., Coll-Risco, I., Porres, J.M., López-Jurado, M., Aranda, P.

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Introduction In the last decades, the combination of high-intensity exercise (HIE) and the intake of high-protein diets (HPD) have been of great interest, specially among athletes and people interested in gaining muscle mass (Aparicio et al., 2011). Oxidative stress plays a critical role in the pathogenesis and progression of chronic kidney disease (Aminzadeh et al., 2014). Thus, the aim of this study was to analyse the scarce information about the effects of HPD and an HIE protocol based on hypertrophy resistance training, on renal redox status. Methods Forty male Wistar rats were randomly distributed into one of 4 experimental groups (n=10): normal-protein diet (NPD) or HPD (10% and 45% soy protein, respectively) with or without HIE for 12 weeks. Thiobarbituric acid-reactive substances (TBARs) and protein carbonyl content (PCC) were assessed. Total superoxide dismutase (tSOD), manganese superoxide dismutase (Mn-SOD), copper/zinc superoxide dismutase (CuZn-SOD), catalase (CAT) and glutathione peroxidase (GPx) antioxidant enzyme activity were measured. Results The HPD groups showed higher values of TBARs levels when compared to the NPD groups (p<0.001). The HPD groups displayed lower levels of tSOD, Mn-SOD, CuZn-SOD and GPx activity compared to the NPD groups (p<0.001, p<0.001, p=0.020 and p<0.001, respectively). The HIE groups exhibited lower levels of PCC and Mn-SOD activity (both, p<0.05), and higher levels of GPx when compared to the untrained groups (p<0.001). Some protein amount\*HIE interactions were found for PCC and Mn-SOD activity such as the higher HIE-induced increased in the HPD groups that was not observed with the NPD (both, p<0.001). Discussion Overall, HPD induced an oxidative status, since an imbalance between oxidative damage markers and the antioxidant defence system was produced. In agreement with our results, a similar study performed also in Zucker obese rats observed that a HPD intake induced renal oxidative stress due to induced accumulation of lipid peroxidation (Namikoshi et al., 2007). References Aminzadeh, M. A., Reisman, S. A., Vaziri, N. D., Khazaeli, M., Yuan, J., & Meyer, C. J. (2014). *Xenobiotica; the Fate of Foreign Compounds in Biological Systems*, 44(6), 570-578. Aparicio, V. A., Nebot, E., Porres, J. M., Ortega, F. B., Heredia, J. M., Lopez-Jurado, M., & Ramirez, P. A. (2011). *Br J Nutr*, 105(6), 836-845. Namikoshi, T., Tomita, N., Satoh, M., Haruna, Y., Kobayashi, S., Komai, N., Kashihara, N. (2007). *Am J Hypertens*, 20(10), 10851091. Contact dcamiletti@ugr.es

### EFFECTS OF DAILY AMOUNT OF SPONTANEOUS RUNNING ON STRESS RESPONSE AND THE RELATED BEHAVIORS IN RATS

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Regular physical exercise can relief stress response and increase stress tolerance. In animal studies, it has revealed that spontaneous running is particularly effective to enhance anti-stress action. However, little is known about conditions during spontaneous running, such as exercise volume, intensity and frequency, in order to confer the anti-stress activity more effectively. In this study, we focused on the effects of daily amount of spontaneous running, i.e. exercise volume, on neuroendocrinal response to several kinds of stress in rats. We also evaluated the stress related behaviors such as anxiety-like and anti-depression behavior. Male Wistar rats were housed individually in cages with or without an attached running wheel and were randomly assigned to either physically active or sedentary conditions. Physically active rats were allowed voluntary access to their wheels for 4 weeks. The rats were screened into high runner or low runner based on the calculated daily running distance. Following to 4weeks running sessions, the rats in both high and low runners were received severe (foot shock) or mild stress (restraint) stimulations. We assessed the levels of brain corticotrophin releasing hormone (CRH), and plasma ACTH and corticosterone using ELISA following to stress stimulations. We also calculated the body and adrenal weight as an index of chronic stress response. Another rats performed anxiety-like behavioral tests, such as open field and elevated plus maze test after 4 weeks spontaneous running sessions. The results showed that CRH levels in the several brain regions following to severe stress stimulation were not different between high and low runner although CRH levels in both high and low runners s received stress stimulations were lower than that in control rat. Plasma ACTH levels after receiving stress in runners were also higher than controls. These results suggest that daily physical exercise indeed induces anti-stress action, but these reactions are independent of amount of physical exercise. The results of behavioral analysis revealed that high runner represented increasing levels of anxiety-like behavior expressions compared to low runner, and suggesting that there are some kinds of difference between high and low runners in mental conditions. These results of present study suggest that it is require investigating the detail of relationship between exercise conditions and anti-stress action.

## Mini-Orals

### MO-SH12 Social science and sport

#### WOMEN'S FOOTBALL – BETWEEN LOCAL ENTHUSIASM AND GLOBAL SUCCESS

Skogvang, B.

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Sport has a unique position in the Norwegian Society, due to the fact that more than one third of the population of about 5 million is involved with organized sport in some way. Sport has always been organized on a voluntary basis. According to the umbrella organization Norwegian Olympic and Paralympic Committee and Confederation of Sports (NIF), only voluntary organizations can be members of the NIF. The development of women's football in Norway has been substantial from about 1,500 registered players in 1975 to 105,595 players today (29 % of all players); the largest organized sport for women since 1995. From the 1990s the Norwegian women's national team has had significant success both in European Championships, World Cups and the Olympics, but still it struggle with acceptance, inclusion and support at club level. In this paper I address how women's football has to act between the local and the global to build a

sustainable sport for the future. The methods applied in the study were fieldwork and qualitative in-depth interviews. Fieldwork was conducted in Norwegian men's and women's football clubs, which mainly offer both elite and grass-root football. All together six clubs (3 with women's football at elite level & 3 with men's football at elite level) were followed closely throughout one year. Observations and informal interviews were carried out during practices, meetings and matches, and in-depth interviews were conducted with eight elite coaches; four in women's & four in men's football. The sample of in-depth interviews carried out with players' consisted of 22 elite football players (11 men & 11 women) aged 19 to 35 years old. These professional footballers had a variety of skills and experiences from newcomers to well-known and skilled players playing at the Norwegian national teams for men and women. The transcribed interviews were coded with main categories and associated sub-categories and cross-analyzed in order to compare each issue across the sample. The main categories were sport carrier (beginning/future plans), positive/negative with football, everyday life in combination with football, gender, status, media coverage, economic conditions, spectators and conflicts. The number of teams for girls and women in Norway has increased to nearly 7,500 teams. The last few years some female elite teams have emerged into male premier league clubs, some of them successfully, and others not. Each team includes not only the players, coaches and team leaders, but also parents, referees, waffle makers, kit washers, and so on, and a larger club might make the work easier, and may attract more sponsors also to women's football. The field work carried out shows that in general women footballers are strongly dependent of enthusiasts and voluntariness at local level. Local sponsors and media, family and friends are crucial for women's football development in Norway and internationally.

### **WILL IT MAKE ME AN INSIDER? MIGRANT WOMEN'S PARTICIPATION IN SPORTS IN THE HELSINKI AREA**

Grochowski, P.

*Univeristy of Helsinki*

This presentation will explore the pathways to participation of migrant women in the Helsinki capital region in Finland. The research questions are: how do migrant women residing in the Helsinki region experience sport and physical activities? Do sports and physical activities provide means for integration of migrant women living in Helsinki? Do sport and physical activities lead to generating feelings of belonging in Finland? The study explores the environments, social histories and social networks which lead to the activation and sustained participation of migrant women in sports and physical activities and provides a critical assessment from the experience of a migrant woman on how life in sports in a new country. The theory of sports participation and belonging has been explored in the Nordic countries (Walseth, 2006; Aggergaard et al. 2010) and this study hopes to provide a Finnish contribution to that debate. Studies reveal that health, well-being and activities in sports are influenced through maternal lines (Nowaki, Radzinska, Rynkiewicz, 2009), family background, socialization and habitus. The study assesses the common thesis that participation in sports can develop a feeling of belonging among migrant groups in the Nordic countries (Walseth, 2006; 2008, 455, 459; Zacheus, 2014). Twelve women from around the world, living in the Helsinki Capital region participated in the study. Qualitative interviews were used for narrative and contemporary accounts on their lives in sports. The study takes an intersectional approach and a standpoint approach (Harding, 1987), to give a voice to a marginalized and belittled group of sport participants. Figurational perspective and Bourdeausian theory serve as the theoretical framework for the study.

### **WHO HAS THE POWER OF THE DEVELOPMENT OF SPORT, THE MEDIA OR THE SPORT?**

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Background and framing of the problem: The research area Sports and Media has grown during the last decade. The power of the media has been highlighted in many investigations out of a media perspective. The investigations have rarely been done out of the perspective of the sports organizations. The main question for this investigation is therefore; who has the power over the development of sport, the sports organization or the media? The organization in focus is the International Ski Federation(FIS). The last decades the society has developed very fast. Two of the areas where this is evident are media and sports. Technology has given new possibilities for both the media and the sport organizations. This has also given opportunities and obstacles to handle for the sport organizations. The scientific base is theories from social science and sport studies, like medialization, media logic and theories of the development of the media and the sport. The theories will be related to empirical data of interviews, articles in the media and statements in the media, both internal and external media. Internal media is the media controlled by the FIS and external media is the media not controlled by the FIS. Other documents related to the questions will be used when necessary, like the Bulletin from the FIS and minutes from their meetings, when possible. Aim and questions This investigation is about how/ if the sports within the International Ski Federation(FIS) have developed in relation to the logic of the media or the logic of the sport during the last decades, how this has affected the development and how officials of the FIS and the agents of media view the development of the sports. The aim is also to analyze the media context and to find out what is expected of a sport in general. How can the sport work in the future and what should it be aware of to be able to take place on the arena of the media and within the awareness of the media audience? What will happen in the future? The subject of the investigation is the International Ski Federation (FIS) and the sport disciplines are ski jumping and cross country skiing. The main questions are: 1. How do the officials in the FIS and the media actors describe ski jumping and cross country skiing? 2. How have the sports developed the last decades; according to the logic of the media and/ or the logic of the sport? 3. Who has the power over the sport development, the sport organization or the media? 4. How does the International Ski Federation's work with internal media channels (website mostly) and with external media.

### **A QUALITATIVE STUDY OF THE FEMALE PRE-SERVICE ELEMENTARY TEACHERS' EXPERIENCES DURING TEACHER TRAINING FOR PHYSICAL EDUCATION**

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Introduction Female elementary school teachers in Korea are out-numbering their male counterparts across the country. This phenomenon is regarded of the problematic factor that atrophy the physical education(PE) because most of female teachers are unwilling to teach PE. So It's very important to cultivate female teachers' ability of teaching PE. This study focused on the female pre-service elementary teachers(PETs)' experiences during teacher training for physical education(TTPE) to explore the experience which can show possibilities to develop female PETs' ability of teaching PE. Thus the purpose of this study was only to investigate the difficulties that the female PETs have experienced during TTPE, also to understand how they have coped with those difficulties. Methods This study used a phenomenological

research method. Participants were 6 female PETs from the national university of education which is located in a local area in Korea. Data were collected by in-depth interview according to the research design, which was based on the Cresswell(1998)'s phenomenological approach. The interview was processed for 5 months from June to November of 2013. The content of the interview, which was carried on through face-to-face interview, mostly includes difficulties what female PETs have experienced during PETE. And then data were analyzed by the phenomenology method which Lincoln and Guba(1985) presented. Results & Discussion The results of this study were summarized in two aspects. The first, the difficulties that female PETs have experienced during PETE were categorized as following themes: Trauma grabbing own ankle, Tasks cannot be chosen, uneasy accompany with others, and No meaning of studying. The phenomenon what female PETs felt more stress than male PETs was connected to the experience of having more difficulties than male PETs. Second, the coping method against these difficulties were categorized as following themes: Depending on time, Gaining others' sympathy, Trying by oneself, and Problem-solving with other's help. Female PETs have tried to solve the problems they encountered. Remarkably female PETs have shown more strength in a specific area. Especially female PETs have played more meticulous role in planning PE class and making teaching materials than male PETs. Conclusively, The femininity of female PETs is considered not only as the barrier factor, but also as the facilitator factor to the TTPE. Conclusively TTPE should be deliberately prepared so that the positive aspect of the femininity should be promoted while the negative aspect of it should be improved. References Cresswell, J. W. (1998). *Qualitative inquiry and research design*. Thousand Oaks: Sage. Lincoln, Y. S. & Guba, E. G.(1985). *Naturalistic inquiry*. Beverly Hills: Sage Publications.

### RESEARCH ON THE PROMOTION OF SPORT FOR OLDER PEOPLE IN CHINA

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Introduction In 2014, the 212.42 million people over 60 in China make up 15.5% of the total population, an increase of 0.6 percentage point from 2013, with the proportion of people over 65 at 10.1%. By 2020, older people in China will reach 248 million. The increase of older people poses great challenges to China's social development, highlighting the importance and urgency of the development of sport for older people. Methods By using the methods of literature research, statistical analysis and investigation at site, this paper aims to research on the basic state of the development of sport for older people, and give suggestions on the future development of sport for older people in China Results In order to guarantee older people's rights to taking exercises and physical activities and adapt to the requirements of an aging society for sports work, China has promulgated and implemented a series of rules, regulation and policies, including Law of the PRC on Physical Culture and Sports, Rights Protection Law of the People's Republic of Elderly People, Regulations on Public Cultural and Sports Facilities, Regulations on National Fitness, National 12th Five-Year Plan for China Ageing Development and National Fitness Program (2011-2015). The General Administration of Sport of China and Chinese Veterans' Sports Association take charge and overall planning of sports work for older people in China, with China Aging Problem National Commission bearing its own share of responsibility. By developing sports organizations and facilities, and encouraging older people to participate in various forms of activities, the authorities concerned try to increase the sport participation rate of older people. Among people aged 20-69, the proportion that exercises or plays sport regularly (at least three times per week, each time for more than 30 minutes and intensity of exercise or sport not below the medium level) rises with the advance of age. Among those who exercise or play sport, older people do so more frequently and for more time. Sport for older people have become an important part of sport for all in China. Discussion Although sport for older people has take shape, there is still more room for development, and policies and measures to promote it need to be perfected and implemented in a more detailed manner. This paper gives the following suggestions: make more efforts to build more older people-friendly sports facilities; train various kinds of social sports instructors in order to meet the different needs of older people; encourage older people to actively participate in voluntary sports activities; strengthen scientific research on sport for older people and actively provide information on opportunities for and benefits of physical activity for older people. References General Administration of Sport of China (2008). "Bulletin About Survey of Participation in Physical Exercises by Urban and Rural Residents in China in 2007". Li X,(2014). On Vigorous Promotion of Sport for Older People. *China Sports Daily* 2014-2-23 First Page.

### MIND THE GAP: YOUTH PROFESSIONAL FOOTBALLPLAYERS NEGOTIATING THE GAP BETWEEN DREAMS AND REALITIES.

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Introduction: The presentation takes its starting point from a project about young professionals in football. I define young professionals as boys who secure youth contracts with football clubs, normally when they are 16 to 18 years old. The project focused upon boys moving from a Swedish club to a club abroad and sought to explore sporting identity and everyday life from a structural level including: globalization, capitalization and professionalization of sports. Methods: The data was collected through semi-structured interviews and observation with 25 youth players, and 25 adults (trainers, agents, scouts, parents). Both the individual micro-level and structural macro-level of sports are used to discuss and analyze general social issues within youth and adult life, masculinity, work and leisure. Discussion: This research, draws attention to the significant gap between young professional footballers dreams, high expectations, and reality. Durkheim's concept of 'anomie' is developed within a sporting context to problematise youth footballplayers everyday-life. Conclusion: The political landscape of professional football is increasingly grounded within a capitalist context. Subsequently, young professional footballers are required to negotiate the 'gap' between dreams, expectations and realities. This research suggests that those athletes who are able to successfully manage this 'gap' are better placed manage both their personal and professional every day lives.

### TURING A SPACE INTO A PLACE: A STUDY OF MIGRANTS' HASHING PRACTICE IN TAIWAN

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Introduction Drawing inspiration from Tuan's concept of space and place (Tuan, 2001), this research uses hashing, a non-competitive trail running sport, as a medium, and aims to reveal the connection between migrants' sporting practice and their identity of place. Methods Qualitative in-depth interviews with 8 foreign hashers living in Taiwan were conducted from September to December 2014. Results 1. A common hash is combined with 2 sections; trail running and socializing drinking party, which create barriers to female participants. 2. Most regular hashers come from western countries with deep-rooted outdoor culture. Eastern migrants are rare to see, and attend occasionally by invitation from friends. 3. Hashers travel around in Taiwan, and keen to participate in various trail running and cross-

country running competitions. Hence, they gain more understanding and cultural identification toward this land and local people. Discussion While many policy makers and scholars focus on using sports as a tool for social integration, however, the elements in modern sport such as rules, opponent forms, equipment and facilities, media and governing organizations may produce alienation from diverse migration backgrounds (Hacısoftaoğlu & Pfister, 2012; Ludwig & Schierl, 2012; Taylor, 2001). On the contrary, researches of hiking and wandering in natural environment show strong evidences related with nationalism, environmentalism, equalitarianism, and humanism (Davidson, 2002; Solnit, 2000; Ween & Abram, 2012). Research found that there is no victory or defeat involved in hashing, thus, participants build a genial relationship through the whole process. In addition, low participation fee and easy access location gives these foreign hashers more opportunities to get closer to local places, and then, attach a sense of togetherness and belongs to places through socializing with local people. Moreover, hashers love nature, and shift their sympathy from natural space to social space, and further, make a meaningless foreign space into a place with care and love. References Davidson, L. (2002). The 'spirit of the hills': mountaineering in northwest Otago, New Zealand, 1882-1940. *Tourism Geographies*, 4(1), 44-61. Hacısoftaoğlu, I., & Pfister, G. (2012). Transitions: life stories and physical activities of Turkish migrants in Denmark. *Sport in Society*, 15(3), 385-398. Ludwig, M., & Schierl, T. (2012). Sport, media and migration: use of sports media by Turkish migrants and its potential for integration. *Sport in Society*, 16(1), 94-105. Solnit, R. (2000). *Wanderlust. A History of Walking*. New York: Viking Books. Taylor, T. (2001). Gender and cultural diversity in sport organisations. *World Leisure Journal*, 43(3), 31-41. Tuan, Y.-f. (2001). *Space and Place: the Perspective of Experience*. Minneapolis: University Of Minnesota Press. Ween, G., & Abram, S. (2012). The Norwegian Trekking Association: Trekking as Constituting the Nation. *Landscape Research*, 37(2), 155-171.

## CHILDREN'S CULTURE AND MOTOR SKILLS LEARNING

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Introduction Children's culture, object of study of Sociology of Childhood, covers various forms of play, among which are the traditional games practiced by groups of children in the streets, squares and schoolyards such as hopscotch, jump rope, kite, marbles, hide-and-seek, etc. In a dialectic articulation between action and thought, children need to master body movements that require a certain level of learning. Traditional games are activities that provide an exceptional set of motor experiences through which the child learns new moves and bodily possibilities (Mello, 2006). The objective of this study was to analyze the learning process of children in their attempt to master the existing complex motor skills in traditional games. The theoretical framework comprised a trans-disciplinary dialogue between the Sociology of Childhood (Corsaro, 2005; Sirota, 2006) and the historical-cultural theory (Vygotski, 1997). Methods The study followed a qualitative approach of ethnographic orientation. Fieldwork was conducted in a public elementary school located in the city of Rio de Janeiro, with children ranging from 6 to 10 years of age who freely played traditional games in the schoolyard. The tools used included observations of the children during their games, records in field journals, audio, photographs, personal interviews and interviews with groups of children. Discussion of Results Following the theoretical and methodological orientation of the Sociology of Childhood according to which children are actors of social processes (Sirota, 2001; 2006), we collected the children's testimonial statements on how their learnings of motor skills take place in the practice of traditional children's games, being these data central to our research. The observations and statements indicated that the learning of motor skills of traditional games occurs initially by imitation in the group to which the child belongs. The child observes and tries to reproduce the movement made by another child. However, the observation and movement reproduction are not enough for the child to fully master the necessary movements of the games, especially those which are more complex. It is fundamental to have the mediation of peers with a deep knowledge of the movements required by the game so that the child can make progress in his learning. The learning of movements in traditional games occurs under conditions predisposed by the zone of proximal development (Vygotski, 1997) through collaboration and guidance among peers. References CORSARO, W (2005). *The sociology of childhood*. T. Oak: Pine Forge Press. MELLO, AM (2006). *Psicomotricidade, educação física e jogos infantis*. SP: Ibrasa. SIROTA, R (2001). *Emergência de uma sociologia da infância*. Cad. Pesq. 112, 7-31. SIROTA, R (2006). *Éléments pour une sociologie de l'enfance*, Rennes: PUR. VYGOTSKI, L (1997). *Pensé et langage*. Paris: La Dispute.

## HOCKEY... AND THEN WHAT? GENERATIONS OF PLAYERS FACING EDUCATION

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Introduction This contribution discusses the impact of professionalization on hockey players' choices of post-compulsory education by observing 3 generations of players. It attempts to explore 3 identified dimensions at work in this process: sports commitments, training paths and parental attitudes. The analysis suggests thinking of these dimensions in terms of figurations (Elias, 1985). Methods Our population comprised Swiss hockey players born between 1963 and 1992 who played in one of the two highest levels of the Swiss hockey league system. The players were distributed into 3 cohorts: 1963-1972(C1), 1973-1982(C2) and 1983-1992(C3). 1814 players corresponded to these criteria and 605 players answered our biographic questionnaire. We enhanced the results through 36 in-depth interviews. We created the sampling of the players from the data of the questionnaire, which allowed us to vary profiles in terms of cohort, social origin and type of education. Results The data suggest a progressive empowerment of professionalization' access paths. The market, previously marked by a bigger inertia, registered more circulation and competition over the generations. Career ambitions appear early and have gradually grown from a local to an international radiance and from sports to professional ambitions. The interactions with the parents are determining on choices regarding education. Results show a more elitist social recruitment and a stronger implication of the parents in education but also in the sports activity. Over the cohorts players opted for general training, which allows extending the uncertainty to the choice of their future trade. If the C1 players mainly turned to a manual vocational training, the C2 players, who still do not benefit from adapted structures, turned to arranged training. A significant share of C3 players continues their education in a sport-study structure but also did not pursue a post-compulsory education. Thus we pass gradually from a compartmentalized figuration, where the relations between sport and education are very weak, to an embedded figuration (Granovetter, 1985). Discussion If we learnt a trade for the future by realizing a "sports break", the sports career gradually stands out as a stage of the occupational career, even of education. Engaging in sport means being part of a new universe where progressive adherence to the norms can conflict with education norms. Besides, at comparable social levels, if the parents' attitude influences schooling, then the evolution of the social profile of families furthers greater closeness with the sports space and the sharing of a sports doxa (Bourdieu, 1994). References Bourdieu, P. (1994). *Practical Reason: On the Theory of Action*. Stanford, University Press. Elias, N. (1985). *La société de cour*, Paris, Flammarion. Granovetter, M. (1985). Economic action and social structure : the problem of embeddedness, *The American Journal of Sociology*, vol.91, p.481-510.



## Mini-Orals

### MO-SH07 Sport management

#### THE SURVEY OF ORGANIZATIONAL COMMITMENT AND CLIMATE OF ORGANISATION OF TURKISH SPORTS SCIENTISTS

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**Introduction** The organisational commitment of individuals and climate of organisation which are among the factors affecting success of organisations directly in our quickly developing and complexifying world draw quite a lot of attention of management scientists. The commitment of employees on the organisation is required to be kept in a high level to increase the productivity and quality of universities as in every organisation. This issue mentioned is undoubtedly among the most important factors in increasing the contribution of sports scientists to the universities. In this research which has been carried out in theoretical and empiric level, the relationships between organisational commitment of sports scientists and the climate of organisation have been analysed. Method A questionnaire has been applied to 110 volunteer academicians in order to determine the levels of organisational commitment of the sports scientists who work in the high schools and faculties of Physical Education and Sports of the universities in Turkey within the scope of this research. "The Scale of Organisational Commitment" which was developed by Meyer and Allen (1990) and the scale of "Climate of Organisation" which was developed by Litwin and Stringer (1974) have been used as tools of data collection. The data have been evaluated using SPSS software version 15.0 for Windows, descriptive statistics have been obtained, one way variance analysis was performed for the comparison of more than two groups and t-test was performed in order to find out whether there is statistically significant difference between the mean scores of the variable groups. The results obtained have been evaluated in the range of %95 reliability  $p < 0.05$ . Results When the level of organisational commitment of participants ( $n=73$ ) was analysed, it was seen that their level of commitment is quite high. It was found out that the participants whose levels of commitment are high are the individuals who are more emotionally dependent on the institution  $p < 0.05$ . The fact that 80,3% of the participants, which is quite a high proportion, state that they find opportunities to develop themselves in the institution confronts us as another important matter which increases their organisational commitment. In the analysis which was carried out on the relationship between the perception of climate of organisation and the socio-demographic qualifications, a difference was determined in terms of the variable of position  $p < 0.05$ . Discussion As a result, it can be said that emotional commitment of the participants on their work and institution is intensive. In this context, it can be stated that the participants like their work and institution. In order to create a healthy climate of organisation in Sports Sciences, administrative decision making and involving in processes of policy making, taking the needs of employees and their opinions into consideration and maintaining work and organisational coherence are considered obligatory for high performance. References 1- Allen N.J. and Meyer J.P. (1990). *J. of Oc. Psy.*, 63, 1-18

#### MEGA SPORTING EVENTS AND THE DEVELOPMENT OF SPORT SCIENCES IN BRAZIL

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**Introduction** Mega sporting events impact the host cities and countries in different ways. They also generate different types of legacy. Among the most important are: economic, social, cultural, environmental, image and knowledge. In this study, we focused on the effects of the 2014 FIFA World Cup and the 2016 Olympic and Paralympic Games in the development of Sports Science in Brazil. Method Data collection was conducted with the collections and databases of the Federal Government and major Brazilian universities. The effects of mega sporting events in the development of Sports Science in Brazil, were considered with reference to five aspects: a) scientific publications on mega sporting events; b) ongoing research on mega sporting events; c) research in progress that are not about mega sporting events, but were driven by them; d) financial support for research on mega sporting events or driven by them; e) establishment of research and higher education institutions in the country driven by mega sporting events. Results and discussion a) Scientific publications on mega sporting events The analysis of the Brazilian scientific publications showed that until the mid-2000s studies on mega sporting events were scarce in the country. The situation changed significantly by 2007. Since then, researchers from different disciplines, with significant contributions from economics, business administration, tourism, geography, sociology and physical education, have analyzed mega sporting events. b) Ongoing research on mega sporting events There are numerous ongoing researches in the country on mega sporting events. Brazilian universities in partnership with the Federal Government carry most of these studies out. Others are performed at the request of entities linked to the organization of these events. c) Ongoing research driven by mega sporting events Though not dealing directly with mega sporting events, there are several studies underway in the country driven by them. These studies involve the production of knowledge, technology development, and construction of storage systems and availability of information for different segments of the Brazilian sport. d) Financial support for research Driven by the mega sporting events taking place in the country, different government agencies have promoted actions and provided financial support for scientific research and technology projects and innovation in the area of sports, including credit lines for studies on the legacy of mega sporting events. e) Research and higher education institutions In close connection to the mega sporting events occurring in the country, there is national committee discussing the possibility to establish a Brazilian University of Sport dedicated exclusively to the training and qualification of professionals and researchers to work in different areas of sport and sport sciences. Conclusion The results of this study support the conclusion that mega sporting events are producing positive effects on the development of the Sports Science in Brazil.

#### THE INVESTIGATION OF THE FACTORS AFFECTING STADIUM ATTENDANCE OF PROFESSIONAL FOOTBALL CLUB SUPPORTERS

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**Aim:** The aim of this study is to investigate the factors affecting the stadium attendance of the supporters of professional football clubs that have stadiums fulfilling the UEFA criteria. **Material and Method:** The study population includes the supporters of Galatasaray Sport Club, Fenerbahçe Sport Club and Kayserispor football clubs participating in Spor Toto Super League in 2013-2014 seasons and having stadiums that fulfill the UEFA criteria. The sample consists of randomly selected ( $n=1237$ ) supporters. As well as demographic data of the

supporters, reasons affecting the Stadium Attendance Scale which consists of 30 questions were used to collect the data. Statistical analysis of the data was done using SPSS 16.0 packet program and descriptive statistics, independent t-test and one-way ANOVA test were applied. Results: The reasons affecting the stadium attendance of the supporters are as follows; opportunity for recreational activities, stadium atmosphere and personal relaxation. On the other hand, the variables affecting the supporters' nonattendance are as follows; negative ergonomic environment and unethical situations. Conclusion: Among the other factors affecting the supporters' attendance to the stadiums, the component of 'Opportunity for Recreational Activities' was found to be the most influential factor. This revealed the necessity of increasing the number of high quality organization related to recreational activities in the stadiums. In the study, the component of 'Negative Ergonomic Environment' was found to be the most influential factor influencing the stadium attendance. In conclusion, negative ergonomic environmental conditions need to be improved to increase the stadium attendance.

### **XPLORING THE RELATIONSHIPS AMONG PLACE ATTACHMENT, PLACE IDENTITY, TEAM IDENTIFICATION, AND FAN LOYALTY.**

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Lamigo Monkeys, a Taiwan professional baseball team (formally known as LANEW Bears since 2003). Since Lamigo Monkeys relocated to Tao Yuan new stadium in 2011, Lamigo has clinched 2 Championship titles (2011 & 2014) and the average number of spectators has risen from 3,016 in 2011 to 6,241 in 2014. Comparing to a 16% glide in the average number of spectators from 2013 to 2014 for the entire league, Lamigo Monkeys is the only team to have a 5% growth rate. According to Wann et al. (2001), fans with strong ties to the local team would likely exhibit a more positive psychological profile than those lacking team identification. Identification with a team from a different city and mere sport fandom per se are not expected to provide significant benefits because these factors do not readily lead to social connections. The driving force behind the benefits of team identification with an individual becomes attached to a larger social group. In addition, place attachment and place identity that originate from environmental psychology are the key terms to explain the relationship between residents and place. Place attachment is generally defined as an emotional tie that individuals develop towards their places of residence, with which they generally maintain close relations. Place attachment is seen as a positive affective bond between people and their place of residence. In addition to attachment, identity is another critical concept to relate to place. The importance of the concept of identity stems from being part of the very essence of place and is intimately related to place attachment. Place identity is a major component of the identity of oneself, manifested through own ideas, beliefs, preferences, values, and objectives that are relevant to such a place, as well as through the way place is understood and perceived. Therefore, the objective of this study is focused on exploring the relationship between team identification and fan loyalty, while understanding the moderating effect of place attachment and place identity on team identification and fan loyalty. The hypotheses of this study are: (1) team identification has significant positive influence on fan loyalty, (2) place attachment can moderate the relationship of team identification and fan loyalty significantly, and (3) place identity can moderate the relationship of team identification and fan loyalty significantly. To conclude, spectators of high level of place attachment or high level of place identity can moderate fan loyalty significantly. This study will enhance the understanding of the moderate effect of place attachment and place identity on team identification and fan loyalty.

## **Mini-Orals**

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### **MO-PM25 Rehabilitation and Physiotherapy: Physiotherapy/Osteopathy**

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#### **A PILOT TEST ON THE EFFECT OF STATIC STRETCHING ON REDUCING THE INCIDENCE OF MUSCULOSKELETAL DISORDERS AMONG TEACHERS IN HONG KONG**

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Purpose: Musculoskeletal disorders (MSD) is a serious and common occupational health problem around the world. With the prevalence rate of 39% to 95%, the adverse impact of MSD on the teaching profession has been reported to be high (Erick & Smith, 2011). Stretching is a potential way to reduce work-related MSD (da Costa & Vieira, 2008). Static stretching is safe and easy to learn. The purpose of study was to evaluate the effectiveness of static stretching on reducing the incidence of musculoskeletal disorders among teachers in Hong Kong. Methods: A total of 47 teachers from 2 primary schools were recruited and participated in the current pilot test. They were group-randomized by school into two groups, i.e. the intervention group (I) and the control group (C). Participants of the I group received the stretching program which was adapted from the "Stretching Exercises to Prevent Musculoskeletal Injury Manual" of the Occupational Safety and Health Council of Hong Kong (2013). The participants were advised to perform a set of 9 static stretching exercises for 15 seconds each and 3 times a day. Log books were provided to record their compliance rates. Participants of group C did not receive any intervention treatment. They were requested to maintain their present lifestyle for 3 months. The assessments of the prevalence rates of MSD were conducted at baseline and third month of the intervention. Results: No statistically significant differences ( $p > 0.05$ ) of prevalence rates of MSD between and within groups were observed. Conclusion: The results showed that static stretching was not effective in reducing the incidence of musculoskeletal disorders among teachers in Hong Kong. The lack of intervention effects might be attributed to the lack of programme contents engagement and small sample size. In order to have more understanding on the effectiveness of static stretching on reducing the incidence of MSD, future studies should be on strategies to increase the compliance rate. References: da Costa, B. R., & Vieira, E. R. (2008). Stretching to reduce work-related musculoskeletal disorders: a systematic review. *Journal of Rehabilitation medicine*, 40(5), 321-328. Erick, P. N., & Smith, D. R. (2011). A systematic review of musculoskeletal disorders among school teachers, *BMC Musculoskeletal Disorders*, 12, 260. Occupational Safety and Health Council (2013). Retrieved on 3 July 2013 from, <http://www.oshc.org.hk/>.

### RELATIONSHIP BETWEEN CHANGE IN MUSCLE STRENGTH AT DIFFERENT MUSCLE CONTRACTION SPEEDS AND CHANGE OF COMFORTABLE GAIT SPEED IN AMBULATORY POST-STROKE PATIENTS

Shimose, R.1,2, Matsunaga, A.2, Hoshi, T.1, Shibata, K.1, Otsuka, T.1, Adachi, S.1, Ichinosawa, Y.2, Shimizu, S.2, Sakamoto, M.2, Suzuki, M.2, Yona, M.3, Muro, M.4

1: Sagami-hara Chuo Hosp. (Kanagawa, Japan) 2: Kitasato Univ. (Kanagawa, Japan) 3: TUPLS (Tokyo, Japan) 4: Toho Univ. (Tokyo, Japan)

**Introduction** One of the main goals of the rehabilitation process in post-stroke patients is to walk independently and practically and it is important to elucidate factors influencing practical walking. Some studies show that gait speed is associated with maximal muscle strength on the affected side. Walking requires instantaneous muscle activity, therefore muscle contraction speed should be considered when the relationship between gait speed and muscle strength is investigated. However, few studies have investigated the relationship between gait speed and muscle strength at different contraction speeds in a cross-sectional and longitudinal manner. We aimed to investigate whether gait speed is associated with muscle strength in slow and fast muscle contraction in acute ambulatory post-stroke patients. **Methods** Eleven post-stroke patients (75 +/- 6 years) who had received inpatient rehabilitation therapy after stroke and could walk independently were enrolled in this study. Exclusion criteria were dementia, low vision, higher brain dysfunction and orthopedic disease. We collected clinical characteristics including age, sex, stroke type and affected side. Comfortable gait speed and isokinetic leg extension torque of affected side at two different constant rates (20 and 40 rpm) were measured twice, on a recumbent cycle ergometer (Strength Ergo 240, Japan), every 2 weeks within one month after the onset of the stroke. Relationships between gait speed and isokinetic peak torque at 20 and 40 rpm were assessed using Spearman's rank correlation coefficient in a cross-sectional and longitudinal manner. **Results** Peak torque of affected limbs significantly correlated with gait speed in both speeds (20rpm;  $r=0.62$ ,  $p<0.05$ , 40 rpm;  $r=0.71$ ,  $p<0.05$ ). Change of peak torque at 20 rpm did not correlate with the change of gait speed ( $r=0.04$ ,  $p=0.9$ ), however change of peak torque at 40 rpm significantly correlated with gait speed ( $r=0.64$ ,  $p<0.05$ ). **Conclusion (Discussion)** An increase in gait speed accompanied by an increase in muscle activity during fast muscle contraction is necessary for improving practical walking. Our results suggest that it is important to increase instantaneous muscle activity of affected lower limbs in order to improve practical gait, and that change of muscle strength during fast muscle contraction could be a suitable parameter for assessing the recovery of neuromuscular function in ambulatory post-stroke patients. Contact: ryota.shimose.17@gmail.com

### EFFECTIVITY OF SLACKLINE TRAINING IN PHYSIOTHERAPY

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**Introduction** – The prevalence of sustaining a sport injury is high in adults. Deficits in postural control and muscle strength represent important risk factors. Therefore, balance and sensomotorik training do play a critical role in physiotherapy and prevention programs. Slacklines are more and more common to train postural control and coordination not just in sports but also in physiotherapy as an alternative to wobble boards. Thus, the purpose of this study is to investigate the impact of Slackline training on postural control and muscle activation patterns. **Methods** – 10 young healthy and active adults, unskilled (<1h Slackline experience), conduct a Slackline training session of 9 x 30 minutes over a period of 6 weeks. Measurements pre and post the training period will be conducted. Outcome measurements are surface EMG of leg muscles and whole body kinematics such as pelvis, trunk and head rotations and translations. Percentage of maximal voluntary contraction (MVC), EMG wavelet analysis and translational and angular deviation and of the pelvis, trunk and head over the whole trial are analyzed. **Results** – Preliminary results show higher activity in % MVC in ankle muscles (M. tibialis anterior: 118%, M. gastrocnemius medialis 104% & M. peroneus 98%) compared to upper leg muscles (M. biceps femoris: 42%, M. rectus femoris: 41%) and pelvic/low back muscles (M. gluteus medius: 34%, M.erector trunci pars lumbalis: 39%). Wavelet analysis to investigate activation frequency and biomechanical analysis of body kinematics are coming up as a next step. **Discussion** – Higher activation of ankle muscles compared to upper leg and pelvic muscles support the theory of a bottom up strategy in balance correcting mechanisms triggered from changes of the base of support. Since correct (re-) weighting of sensory input is essential for successful postural control (Honegger et al., 2013, Küng et al., 2009), Slackline training can be a reasonable method (Pfusterschmied et al., 2013). Ankle proprioceptors are highly activated and complete visual information in a momentarily way. However, if an improvement of postural control on the Slackline does have a great impact on the risk of sport injuries has to be shown in future research. **References** Honegger F, Tielkens RJM, Allum JHJ (2013). Movement strategies and sensory reweighting in tandem stance: differences between trained thightrope walkers and untrained subjects. *Neuroscience*. 254:285-300 Küng UM, Horlings CGC, Honegger F, Duysens JEJ, Allum JHJ (2009b). Control of roll and pitch motion during multi-directional balance perturbations. *Exp. Brain Res*. 194(4):631-645 Pfusterschmied J, Buchecker M, Keller M, Wagner H, Taube W, Müller E (2013). Supervised slackline training improves postural stability. *Eur J Sport Sci*. 13(1):49-57 Contact: u.kueng@physioschule.ch

### INCREASED ENERGY EXPENDITURE DURING ADL BY ELECTRICAL STIMULATION-INDUCED LEG MUSCLE ACTIVATION IN SPINAL CORD INJURY

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**Introduction**. Obesity, increasingly common in individuals with spinal cord injuries (SCI), is for a large part due to an inactive lifestyle and a markedly lower resting energy expenditure (EE) as a result of the paralyzed muscle atrophy. A possible contribution to a solution is by increasing EE by electrical stimulation (ES)-induced activation of the paralyzed muscles. The purpose of our study was to evaluate if ES-induced muscle activation can be used during daily activities to increase EE. **Methods**. Nine men with a chronic SCI (C4/5-T11; ASIA A-C) performed 3 standardized daily activities for 30min each: lying on a bed (L), sitting in a wheelchair reading a book (S), and submaximal wheelchair propulsion on a treadmill (WC) while wearing a garment with built-in electrodes. During 20min of each activity, gluteal, hamstring, and quadriceps muscles were simultaneously activated using ES (50Hz) at individually adjusted comfortable current amplitude levels. EE was derived from oxygen uptake measurements using a portable gas analysis system. **Results**. ES-induced activation was well tolerated by all participants and did not hinder the tasks performed. EE during L, S, and WC with ES ( $416\pm 133$ ,  $375\pm 70$ ,  $673\pm 187$  kJ/hr, resp.) was higher ( $p<0.05$ ) than without ES ( $342\pm 81$ ,  $318\pm 38$ ,  $617\pm 177$  kJ/hr). This suggests that  $\pm 3-4$  hr/day of activation is needed to counteract the average 182 kJ/day excess caloric intake found in SCI (De Groot 2010). **Conclusion**. ES-induced paralyzed muscle activation markedly increases EE during daily activities in SCI and might therefore be a potential way to help counteracting the development of obesity.

**HIGH INTENSITY INTERVAL TRAINING TO IMPROVE FITNESS IN CHILDREN WITH CEREBRAL PALSY**

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**Introduction** Aerobic exercise capacity is limited in children with cerebral palsy (CP) compared with their typically developing peers (Balemans et al, 2013), and there is limited research on the effect of aerobic training in children with CP. Our aim was to assess the effect of high-intensity interval training (HIT) on aerobic exercise capacity, quality of life (QoL) and body composition in children with CP. **Methods** This was a baseline-control trial. Twelve children (7 boys, 5 girls) with CP, gross motor function classification system (GMFCS) levels I-IV, mean age 14 (10-16) years, performed 24 sessions (2-4 per week) of HIT. They aimed to reach at least 85% of their heart rate maximum for 16 of totally 35 minutes each session. The primary outcome, peak and submaximum oxygen uptake (VO<sub>2</sub>peak, VO<sub>2</sub>submax), were measured at enrolment to the study (T0), after a pre-training period (T1) and after HIT (T2). Secondary outcomes were QoL assessed with the KINDL questionnaire and body composition measured using whole body dual-energy X-ray absorptiometry scanning. Results VO<sub>2</sub>peak increased by 17%, from 34.1 (5.6) to 39.8 (6.1) mL·kg<sup>-1</sup>·min<sup>-1</sup> from T1 to T2 (p = 0.017), and since VO<sub>2</sub>submax did not change, the percentage oxygen utilization was reduced. According to parents, QoL improved (p = 0.008), and in particular their children's self-esteem (p = 0.005), but not according to the children themselves. Body composition did not change. **Discussion** Data from controlled clinical trials on the effect of exercise training on VO<sub>2</sub>peak in children with CP is limited. Another study (Unnithan et al, 2007) found VO<sub>2</sub>peak to increase by 18% after three months of combined endurance and strength training (three weekly sessions of 70 minutes with an intensity of 65-75% of predicted HRpeak). In contrast to this study, the participants in our study only exercised for about 35 minutes each time and fewer sessions in total. We argue that time efficiency is particularly important in children with CP as they usually spend more time on activities of daily life. The observed changes in parent proxy reported QoL are not likely to be explained by various expected short-term emotional changes in adolescence, as parents' reports are not affected by these normal fluctuations. **Conclusions** This pilot study showed that HIT can improve aerobic exercise capacity in children with CP. As such training may also improve the children's QoL it should be considered included in individual (re)habilitation programs. **References:** Balemans AC, et al. (2013) *Med Sci Sports Exerc.* 45: 561-8. Unnithan VB, et al. (2007) *Med Sci Sports Exerc.* 39: 1902-9.

**ACUTE ADAPTATIONS OF SPASTICITY-RELATED IMPAIRMENTS AFTER WHOLE BODY VIBRATION – EFFECTS ON STRETCH REFLEX RESPONSES, VOLUNTARY MUSCLE ACTIVATION AND MOBILITY**

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**Introduction** Whole body vibration (WBV) training is widely implemented in multifaceted fitness and health settings. While investigations increasingly demonstrate positive effects of WBV within healthy subjects, the transfer of those adapted underlying mechanisms into a clinical setting is still lacking. Evidence about WBV-induced reduction in spinal excitability (Ritzmann et al. 2011) may be associated with benefits in patients suffering from increased reflex activity (spasticity), thus enhancing motor performance (Ahlborg et al. 2006). Therefore, this study aims to provide evidence about acute neuromuscular and kinematic effects of WBV in children with spasticity, such as in cerebral palsy (CP). **Methods** 29 children with spastic CP were recruited. Before and after one-minute of vibration training (16-25Hz, 1-3mm) stretch reflexes (SR), maximal voluntary contraction (MVC) within leg muscles and active range of motion (AROM) were assessed. Therefore, electromyography of five lower limb muscles (m. soleus, SOL; m. gastrocnemius medialis, GM; m. tibialis anterior, TIB; m. biceps femoris, BF; m. vastus medialis, VM) as well as electro-goniometry of the ankle and knee joint during maximal range of active movement were recorded. SR were measured in the SOL and induced by an ankle ergometer dorsiflexing the ankle passively. Results After WBV, SR were reduced (-9±17%, P<0.05) and subjects demonstrated increased MVCs in the lower limb muscles (SOL +25±46%, GM +35±116%, TA +17±86%, BF +25±74%, VM +12±38%, P<0.05). Kinematic data revealed significantly elevated AROM of the knee joint (+13±20%, P<0.05), but no changes in the AROM of the ankle joint (+2±47%, P=0.44). The MVC/SR-ratio of the SOL revealed a significant gain after WBV (+19±41%, P<0.05). **Discussion** Acute exposure to WBV caused (a) diminished spasticity-related reflexes, accompanied by an (b) increased voluntary muscle activation and mobility within the lower limb. The WBV-induced reduction in spinal excitability may help to reduce the exaggeration of the tonic component of the SR, the abnormal spastic muscle tone and consequently could lead to a decreased co-contraction within the patient's antagonistic muscle groups (Ritzmann et al. 2011). The opposing effects of a down-regulated reflex-activation and an elevated voluntary activation of the neuromuscular system emphasize enhanced motor control after WBV. This may result in improved movement training immediately after WBV, thus may be successfully applied for treatment of neuropathological exaggerated SR. **References** Ahlborg L, Andersson C, Julin P (2006). *J Rehabil Med*, 38(5), 302-8. Ritzmann R, Kramer A, Gollhofer A, Taube W (2011). *Scand J Med Sci Sports*, 23(3), 331-9. anne.krause@sport.uni-freiburg.de

**GOAL-SETTING PRACTICE IN THE SPORT PHYSICAL REHABILITATION SETTING. A PRELIMINARY STUDY ABOUT THE PERCEPTION AND THE USE OF GOAL SETTING AMONG ITALIAN SPORT PHYSICAL THERAPISTS**

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About the return to sport following injury rehabilitation, an area of increasing research interest is the psychological techniques that physical therapists can use and how these interventions can aid significantly to the rehabilitation (1). In particular Goal Setting process seems to have positive clout in the efficacy of the treatment (2). Despite the fact that goal setting is considered by the clinical standard guidelines as an essential component of rehabilitation, the transferability of this process into practice is highly variable and often problematic (3). The aim of this study is starting to investigate in Italy the perception and attitude about the goal setting intervention and the use into daily practice by the sport physical therapists. Starting from the PSPQ(4) and the AAI(5), we developed a new questionnaire done by three parts. 58 sport physiotherapists were asked to complete this questionnaire concerning their opinions and experiences about use of goal setting. Qualitative analysis of the data showed a high consideration of goal setting: most of them think that will help to faster rehabilitation process and increase the patience adherence. However some data show that probably goal setting is often confused with the process of decision making at the beginning of the treatment program. Among Italian Sport Physical therapists Goal setting was never studied before and so a further and deeper study need to be done in order to explore in more detailed way how this complex intervention is used in the daily practice and to improve professional practice, guidance and education. (1)Leslie P, James D, John M(2011). A review of return to sport concerns following injury rehabilitation: Practitioner strategies for enhancing recovery outcomes. *Physical Therapy in Sport* 12,36-42; (2)Barnard R, Cruice M, Playford E(2010). Strategies used in the pursuit of achievability during goal setting in rehabilitation. *Qual*

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### COGNITIVE FUNCTIONS OF PARKINSON'S DISEASE PATIENTS CAN IMPROVE WITH PHYSICAL EXERCISE

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**INTRODUCTION** Decline in cognitive functions can be included as cardinal signs/symptoms of PD. Cognitive functions in this population have been affected to physical exercise interventions. However, none study compared the physical exercise interventions in relation to cognitive intervention. To compare the effects of physical and no physical exercise interventions on cognitive functions in Parkinson's disease (PD) patients. **METHODS** One hundred and twenty PD patients (68.8±8.6 years old) were randomly assigned into three groups: (i) functional capacity exercises (n=40); (ii) mobility program (n=40); and (iii) cognitive intervention (n=40). Patients were in mild to moderate disease stages (1 to 3 of Hohen & Yahr and 41±16 points in the UPDRS) and had the cognitive functions preserved (Mini-Mental State Examination=27.8±2.3 points). The clinical and cognitive functions were assessed before, after 4 and 8 months of intervention. All assessments and practice sessions were done in on-medication state. **RESULTS** Only participants that completed 70% of the practice sessions and all assessments were included in the analysis: (i) functional capacity exercises (n=37); (ii) mobility program (n=32); and (iii) cognitive intervention (n=34). There were neither group differences nor group and moment interactions for any dependent variable. Univariate analysis for moment revealed differences in attention, mental flexibility and memory. Participants increased the score in symbol search (p<0.01), decreased the perseverative errors (p<0.01) and showed higher performance in episodic declarative memory (p<0.001) and immediate memory (p<0.002) from pre to 4 and to 8 months of intervention. **CONCLUSION** Physical and no physical exercise interventions were able to improve cognitive functions in Parkinson's disease patients probably due to the increase of brain oxygenation and stimulation in physical exercise interventions and the specificity of activities in the cognitive intervention. **CONTACT** Itlgobbi@rc.unesp.br

### EFFECT OF RADIOFREQUENCY HYPERTHERMIA TREATMENT IN RUNNING BIOMECHANICAL PARAMETERS

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**Introduction** Exhausting training sessions have, in the short term, a negative impact on sport performance. One reason could be the worsening of their running economy associated with alterations in the running biomechanics. Physiotherapy has been used to accelerate recovery and to improve sport performance. However, there is no clear scientific evidence about its effectiveness (Torres et al., 2014). In the last few years, there has been an increasing utilization of radiofrequency hyperthermia (RFH) in sport. This is a widely used technique to facilitate the recovery of muscle function. Thus, the aim of the present study was to determine the effect of RFH therapy in biomechanical parameters related with running economy. **Methods** All the subjects (n=10) performed two protocols (separated by 2 weeks). Both consist of one exhausting training session followed by a treadmill test 1 day after. One hour after this test, in one protocol participants underwent RFH therapy and in the other they did not receive physical therapy. Both groups repeated the test 2 days after the first test. Participants were randomly assigned to begin with RHF or control protocol. The participants in each protocol completed two incremental running tests, which started at 10 km.h<sup>-1</sup>. The speed was increased by 2 km.h<sup>-1</sup> every 6 minutes until 16 km.h<sup>-1</sup> was reached, with a minute of recovery between each stage. Stride angle, ground contact time, swing time and stride length and frequency were measured for every step during the treadmill test using an optical measurement system (Optojump-next, Microgate, Bolzano, Italy) placed at the treadmill belt level (Santos-Concejero et al., 2014a). Data were analyzed statistically using a paired Student's t-test. **Results** Athletes who received RFH increased their stride angle, stride length, swing time and stride height values, after their 48 hour recovery, more than the control group. Accordingly, stride frequency values decreased more after applying RFH. **Discussion** Biomechanical parameters recovered better when athletes were treated with RFH than when they were not treated. Since these biomechanical parameters are related to running performance (Santos-Concejero et al., 2014b), we can conclude that RFH could be a good tool for improving the recovery of athletes after exhausting exercise sessions. **References** Santos-Concejero J, Tam N, Granados C, Irazusta J, Bidaurrazaga-Letona I, Zabala-Lili J, Gil SM. J. (2014). *Strength Cond Res.* 28, 1889-1895. Santos-Concejero J, Tam N, Granados C, Irazusta J, Bidaurrazaga-Letona I, Zabala-Lili J, Gil SM. (2014). *Int J Sport Sci* 10, 95-108. Torres R, Ribeiro F, Duarte JA, Cabri JMH. (2014). *Physical Therapy in Sport.* 13, 101-114. Contact jon.irazusta@ehu.es

## Mini-Orals

### MO-PM27 Sports Medicine and Orthopedics: Orthopedics

#### PREVALENCE OF BACK PAIN IN ELITE ROWERS

Felker, K., Fett, D., Platen, P.  
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**Introduction** Back pain (BP) is a frequent health problem in the general population resulting in enormous costs for the health care system. BP is also one of the most frequently occurring complaints in sports. It is reported by approximately 30% of athletes. Detailed data on prevalence of BP in German sportsmen and women is rare. Elite rowers are exposed to high strain on the musculoskeletal system and especially on the lower back due to their sport-specific loads during training and competition. Currently, there is no information on the prevalence of BP in German elite rowers. This study aims at identifying lifetime prevalence (LP) and point prevalence (PP) of BP in German elite rowers with special emphasis on the exact localization of the pain region. **Methods** N=84 German elite rowers (m=43, f=41; 20.7±3.4 yrs., 183.9±8.3 cm, 77.3±11.5 kg) on international and national competition level were asked to fill out an online questionnaire based on the validated "Nordic Questionnaire" (Kuorinka et al., 1987). The questionnaire included several items on BP, separated in pain

in the cervical, thoracic and lumbar spine region. Further, it included questions on lifetime occurrence of BP and on BP during the last 7 days. Results LP of BP was 96.4% being highest in the lumbar spine (86.9%), followed by the neck (65.5%) and the thoracic spine (57.1%). PP of BP was 67.9% being again highest in the lumbar spine (47.6%), followed by the neck (29.8%) and the thoracic spine (20.2%). Discussion Our findings indicate that BP is a relevant medical problem in German elite rowing. Especially pain in the lumbar spine seems to be omnipresent with a LP of nearly 90% and a PP of nearly 50%. This prevalence data is much higher compared to findings in the literature. Bahr et al. (2004) described a LP of low BP of 63.3% and a PP of 25.3% in elite rowers, and Foss et al. (2012) found a LP of low BP of 68% and a PP of 19%. One possible reason for the very high prevalence values of BP in German elite rowers might be very high sports-specific and strength training loads. This has to be evaluated in further studies. The results underline the necessity of BP prevention programs in addition to the discipline specific training loads. Literatur Bahr, R., Anderson, S.O., Loken, S., Fossan, B., Hansen, T. & Holme, I. (2004). Low Back Pain Among Endurance Athletes With and Without Specific Back Loading – A Cross-Sectional Survey of Cross-Country Skiers, Rowers, Orienteers, and Nonathletic Controls. *Spine*, 29 (44), 449-454. Foss, I.S., Holme, I. & Bahr, R. (2012). The Prevalence of Low Back Pain Among Former Elite Cross-Country Skiers, Rowers, Orienteers, and Nonathletes. A 10-Year Cohort Study. *Am J Sports Med*, 40 (11), 2610-2616. Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sørensen, F., Andersson, G. & Jørgensen, K. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics*, 18 (3), 233-237. Acknowledgement The study was supported by the Federal Institute for Sport Science, Germany (ZMV11-080102A/11-18).

### **MONITORING PERCEIVED STRESS, RECOVERY AND NON-TRAUMATIC LOWER EXTREMITY INJURIES IN COMPETITIVE RUNNERS**

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Introduction Runners often sustain lower extremity injuries (19-79%) (van Gent et al, 2007). In a theoretical model it has been described that a disturbance in perceived stress and recovery can increase the risk of sustaining an injury (Williams & Andersen, 1998). Therefore, the purpose of this study was to investigate changes in perceived stress and recovery preceding an injury of competitive runners. Methods Twenty-four competitive runners were monitored over one full training season (46 weeks). Every week, the runners filled an on-line RESTQ-sport (Nederhof et al, 2008). Furthermore, runners and their coaches kept a log with injuries and physical complaints. A non-traumatic injury was defined as any pain, soreness or injury that was not caused by trauma and resulted from training and led to a decrease in training duration or training intensity for at least one week (Jacobsson et al, 2013). Because baseline levels of perception of stress and recovery vary largely between runners, the 19 scales of the RESTQ-Sport were normalized to Z-scores based on the runner's individual average and standard deviation of the whole season (excl. injured periods). The normalized scores of 1, 2 and 3 weeks before the first sustained injury were compared to 0, which is the average normalized score, by repeated measures ANOVA's. Results Twenty-two runners sustained a non-traumatic lower extremity injury. Eight of these runners filled out the RESTQ-Sport all 3 weeks preceding the injury and their data was used for further analysis. The injuries sustained were non-traumatic injuries of the knee, Achilles tendon, ankle, foot and shin. It was shown that 1 week preceding the injury, runners scored lower than the average normalized score on "Success" (Z-score:  $-0.68 \pm 0.62$ ) and 2 weeks preceding the injury runners scored higher than their average on "Fitness/Injuries" (Z-score:  $1.04 \pm 1.12$ ). Discussion A decrease in perceived success may be a marker to predict a non-traumatic lower extremity injury. Also an increase in the perception of muscle ache, soreness, pain and vulnerability to injury ("Fitness/Injury") preceded injuries. Thereby, monitoring changes in individual stress and recovery may help to prevent non-traumatic injuries. References Jacobsson, J., et al. (2013) *Br. J. Sports Med.*, 47(15), 941-952 Nederhof, E., et al. (2008) *Int J Sport Psy.*, 39(4), 301-311. van Gent, R. N., et al. (2007) *Br. J. Sports Med.*, 41(8), 469-80 Williams, J. M., & Andersen, M. B. (1998). *J. Applied Sport Psy.*, 10(1), 5-25. Contact t.a.otter@pl.hanze.nl

### **PREDICTIVE VALUE OF LOWER LIMB MUSCULOSKELETAL SCREENING FOR INJURY RISK IN ELITE AUSTRALIAN FOOTBALL PLAYERS**

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Objectives: To examine the relationship between pre-season musculoskeletal screening test (MST) performance and lower limb (LL) intrinsic injury risk in elite Australian football (AF) players. Design: Prospective cohort study. Methods: Players (n = 71) from one club were involved; screening and injury data was examined from the club's database across the 2011-14 seasons. Pre- and in-season phases were studied, with in-season further separated into rounds 1- 8, 9-16 and 17+. Eight MST were conducted annually at the beginning of pre-season, with performance rated as desirable/undesirable by club physiotherapists. For individual tests, relative risk (RR) was calculated to determine comparative injury risk between desirable/ undesirable MST outcomes. A logistic regression (using odds ratios: OR) determined the best combination of MST for predicting injury. Results: Individually, across pre-season and the whole-season (pre- and in-season combined), groin squeeze was the best predictor of injury. In-season, groin squeeze and Thomas test (TT) hip flexors were the best predictors of injury. In combination, across the whole-season groin squeeze was the best injury predictor. During pre-season, sit and reach was the best injury predictor. In-season, TT hip flexors, groin squeeze and calf raise were the best injury predictors, and for rounds 1-8; TT hip flexors, rounds 9-16; sit and reach, round 17+; none. Conclusions: These findings support the use of several MST in elite Australian football. In particular, groin squeeze, sit and reach, calf raise and TT hip flexors MST may be most useful for predicting injury, particularly in the early in-season, as opposed to the later stages.

### **MUSCULOSKELETAL INJURIES IN ELITE JUNIOR TENNIS PLAYERS**

Fett, J., Ulbricht, A., Ferrauti, A.

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Introduction In tennis, modern game has evolved from a primary technical sport to the current explosive sport becoming increasingly dynamic and faster with higher stroke and serve velocities which require notably higher demands of physical fitness (Kovaks, 2007). Due to this evolution and a tournament schedule no less demanding it has led to an increased strain for players in training and competition which may concurrently result in a higher risk of overuse injury and drop-out. Therefore, the aim of the present investigation was to identify prevalence of musculoskeletal symptoms in elite junior tennis players with special regard to the upper extremity. Methods Prevalence of musculoskeletal symptoms was recorded in 107 nationally ranked junior tennis players (n=60 males,  $14.9 \pm 2.5$  yrs,  $171.2 \pm 13.9$  cm,  $58.6 \pm 15.4$  kg; n=47 females,  $14.6 \pm 2.1$  yrs,  $166.1 \pm 10.9$  cm,  $54.1 \pm 10.6$  kg) by a questionnaire developed in accordance to the standardized

Nordic Questionnaire (Kuorinka, 1987). The applied questionnaire includes life time prevalence of musculoskeletal symptoms (LPMS), 12-month prevalence (12MP) regarding limitations of the upper extremity and in accordance to defined stroke performance, as well as a pain severity measurement throughout serve performance. Chi-square statistics were used to determine differences in LPMS and 12MP between gender, age group and performance level. Results Highest LPMS was found in the body regions of the knee (54%), shoulder (50%), hand (45%) and lumbar spine (45%) followed by ankle, hip, neck, elbow and thoracic spine (<40%). Reported 12MP of upper extremity limitations revealed the highest scores for shoulder region (32%) followed by the hand (25%) and elbow (19%). Discomforts of the shoulder and elbow are mostly allied to the serve performance (>75%) while limitations occurring in the hand are more likely to be related to forehand strokes (80%). Highest pain score during serve performance was recorded in the body region of the shoulder (4.4). Comparison of gender and age showed no significant differences in any LPMS and 12MP. Significant differences ( $p < .05$ ) between performance level were found in LPMS of lumbar spine (59 vs 27%), hip (50 vs 11%) and elbow (32 vs 11%). Discussion Results obtained indicate high prevalence of musculoskeletal symptoms in elite junior tennis players especially in the upper extremity. Regarding the upper extremity the shoulder being the most frequently involved body region which discomforts are notably allied to the serve performance. Moreover, players of a higher performance level seem to be at a higher risk of injury. More efforts are necessary for developing training prescription for both, prevention strategies and performance enhancement. References Kovaks, M (2007). *Sports Med*, 37, 189-198. Kuorinka, I et al. (1987). *Appl Ergon*, 18, 233-7. Contact janina.fett@rub.de

## PREVALENCE OF BACK PAIN IN ELITE FIELD HOCKEY PLAYERS

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Introduction Back pain (BP) is a frequent health problem in the general population resulting in enormous costs for the health care system. Detailed data on prevalence of BP in German sportsmen and women is rare. From a biomechanical perspective movements in field hockey are characterized by forward flexion and rotation of the trunk. The forward flexed posture must be maintained during most of the duration of a game or training session causing high spinal loads. This might be associated with the development of pain in the back. The aim of the present investigation was to determine the lifetime prevalence and point prevalence of BP in German elite field hockey players to clarify associations between hockey-specific posture and pain generation. Methods A self-reported standardized and validated questionnaire based on the Nordic questionnaire by Kuorinka et al. (1987) was sent to all members of the German field hockey national team and the members of the State-of-Northrhine-Westfalia junior hockey team. The questionnaire included several items on BP, separated in pain in the cervical, thoracic and lumbar spine region. N=107 field hockey players (47.8%) responded (m = 44, f = 51; age:  $19.3 \pm 4.5$  yrs., height:  $174.1 \pm 9.2$  cm, weight:  $66.3 \pm 10.3$  kg, mean  $\pm$  SD). Results The reported lifetime prevalence of BP in field hockey players was 85.3%. Regarding different parts of the spine, lifetime prevalence of pain in the cervical, thoracic and lumbar region were 58.1%, 37.6% and 72.3%, respectively. N=38 field hockey players experienced BP during the previous seven days (40.0%). Seven-day prevalence of pain of the cervical, thoracic and lumbar region revealed values of 18.9%, 12.5% and 27.8%, respectively. Discussion We found a high prevalence of BP in German field hockey players with the most frequent localization in the lower back. Our results clearly revealed much higher prevalence of BP compared to other studies. Murtaugh (2001) reported lifetime prevalence of BP of 59% and of pain in the lumbar region of 54% in field hockey players. Reilly et al. (1990) and Haydt et al. (2012) also found lower prevalence of low BP (53% and 56%, respectively). A possible reason for the higher prevalence in our study could be the high performance level of the players and the associated high training loads. The results of our study underline the necessity of specific prevention programs for BP in elite field hockey players. Acknowledgement The study was supported by the Federal Institute for Sport Science, Germany (ZMVI1-080102A/11-18). References Haydt et al. (2012). *Int J Sports Phys Ther*, 7(3), 296; Kuorinka et al. (1987) *Appl Ergon.*, 18 (3), 233; Murtaugh (2001). *Med Sci Sports Exerc*, 33(2), 201; Reilly et al. (1990). *J Sports Med Phys Fitness*, 30, 142. Contact daniela.fett@rub.de

## CHARACTERISTICS OF INTRATENDINOUS MICROCIRCULATION SHORTLY AFTER AN ACHILLES RUPTURE AND TREATMENT OUTCOMES AFTERWARD

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Introduction Studies have posited that tendon vascular supply is crucial to healing. Therefore, the aim of this study was to observe microcirculation (total hemoglobin [THb] and oxygen saturation [StO2]) values in injured Achilles tendons 1, 2 and 3 months after repair. Furthermore, to investigate the microcirculatory changes between each time point and the correlations with outcomes measured 3 and 6 months post-surgery. Methods Nine subjects (median age: 44 years; range: 34.8–51.9 years) with a repaired Achilles were recruited. The subjects were measured at 1, 2, 3 and 6 months post-surgery. Bilateral measurements of tendon microcirculation were recorded at the first three time points, while outcome measures of tendon stiffness, a Taiwan Chinese version of the Victorian Institute of Sport Assessment Scale-Achilles questionnaire (VISA-A-TC), one-leg hopping distance (OLHD), the star excursion balance test (SEBT) and the heel raise index (HRI) were conducted and/or measured at the third and fourth time points. Correlations between the microcirculatory changes, e.g., between the measurements at 2 and 1 month (2-1) post-surgery, at 3 and 2 months (3-2) post-surgery and at 3 and 1 month (3-1) post-surgery, and the outcome measures were investigated. Results The THb2-1 and 3-2, StO2 2-1 and StO2 3-2 showed correlations with the HRI, SEBT, OLHD and VISA-A-TC scores ( $\rho$  -0.900–0.900). Furthermore, compared to the non-injured tendons, the repaired Achilles demonstrated greater THb (at 1, 2 and 3 months) and StO2 (at 3 months). Discussion This study demonstrated that changes in the microcirculation levels at 1, 2 and 3 months post-surgery were correlated with self-reported symptoms and limb symmetry of functional outcomes afterwards. Our results implied that large changes in THb are associated with great asymmetry of lower extremity functions, including balance and muscle explosiveness as well as a highly symptomatic repaired tendon. This may be because during the initial inflammatory phase after tendon rupture, the angiogenic growth factors are involved in inducing endothelial cell proliferation and migration, as well as the expression of other growth factors and the stimulation of extracellular matrix changes to accommodate cellular migration (Boyer et al., 2001, James et al., 2008). More studies are required to determine whether physical therapies including modalities or exercises would result in improvements in microcirculation for the purposes of recovery in humans. References Boyer MI, Watson JT, Lou J, Manske PR, Gelberman RH, Cai SR. (2001). *J Orthop Res*, 19, 869–872. James R, Kesturu G, Balian G, Chhabra AB. (2008). *J Hand Surg Am*, 33, 102–112.

**POTENTIAL UTILITY OF VIBRATIONAL ANALYSIS FOR EARLY DETECTION OF SPONDYLOLYSIS**

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Introduction Lumbar spondylolysis refers to a defect of the vertebral pars interarticularis and is among the most common causes of low back pain in adolescent athletes. There is potential for the fracture to heal at an early stage of spondylolysis, but healing is more difficult at an advanced stage (Sairyo et al., 2012). Diagnosis in the early stage is therefore desirable to promote sufficient healing. A diagnostic method has been reported that detects bone fracture by analyzing the vibrational signals produced by stimulating the bone (Singh et al., 1989). Such vibrational analysis may also be applicable to the detection of stress fractures such as spondylolysis. The purpose of this study was to investigate whether vibrational analysis can be used to detect spondylolysis in sham bone. Methods Four versions of a synthetic fifth lumbar vertebra model (Sawbones, SAW1352-10) were created: an intact model of the pars without incision, two unilateral defect models, and one bilateral defect model. In the unilateral defect models, an incision was made either of one half of the diameter (50% defect model) or the entire diameter (100% defect model) of the left pars. In the bilateral defect model, incisions were made of one half of the diameter of the right pars and the entire diameter of the left pars (50%+100% defect model). Hammering was performed five times on each spinous process of fixed sham bone and the vibrational signals were measured using an accelerometer attached to the contralateral side of the hammer. Signals from trials 2 to 5 were analyzed using the fast Fourier Transform technique. The root mean square of electromyography (EMG) amplitude was calculated in the range of 50 to 1000 Hz. One-way analysis of variance (ANOVA) test and Tukey's honestly significant difference test were used to determine significant differences in EMG amplitude among the four models. Results EMG amplitude differed significantly among three of the models ( $F = 107.47$ ,  $P < 0.01$ ). EMG amplitude was significantly lower in the 100% defect model (14.35 dBV) and 100%+50% defect model (9.51 dBV) than in the intact model (30.54 dBV) and 50% defect model (29.32 dBV;  $P = 0.00$ ), as well as in the 100%+50% defect model compared with the 100% defect model ( $P < 0.05$ ). Discussion These findings suggest the potential utility of vibrational analysis in the diagnosis of lumbar spondylolysis in cases of complete unilateral pars fracture and in more progressive disease. References Sairyo K, Sakai T, Yasui N, Dezawa A. (2012). *J Neurosurg Spine* 16, 610-614. Singh VR, Yadav S, Adya VP. (1989). *J Biomed Eng*, 11 (6), 457-461. Contact mm14023y@st.kitasato-u.ac.jp

**A COMPARISON OF NATURAL KNEE AND TOTAL KNEE ARTHROPLASTY KINEMATICS DURING THE GOLF SWING**

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Introduction Increasingly younger, more active patients are recipients of total knee arthroplasty (TKA) implants. Golf is a popular post-surgery sport recommended by surgeons. However, discomfort has been reported by 16% of golfers with a TKA during play and 35% after play (Mallon & Callaghan, 1993). The present study was devised to: 1. Determine if persons with a TKA have an equivalent swing period to natural-knee (NK) golfers. 2. Compare when extremes of knee rotation occur in the TKA and NK. 3. Quantify and compare the range of knee rotation in TKA and NK golfers. Methods Twenty-four male golfers were recruited: 12 NK, 4 left TKA (LK), 4 right TKA (RK) and 4 bilateral TKA (BK). All TKA golfers had the Depuy LCS cruciate sacrificing, rotating-platform implant. Bilateral knee kinematics and the golfer's driver were measured in 6DoF. Six trials per subject were captured. The instant min. and max. angle was reached and the absolute range of rotation in each knee axis was identified. Values were expressed in terms of percentage swing between take-away and mid follow-through. Between-group mean swing times were compared using a one-way ANOVA with pairwise group comparisons. Variables exhibiting a normal distribution were compared using the GLM, the remainder were analysed using Kruskal-Wallis. Results No significant differences were found between group mean swing times ( $sig.=0.05$ ). Maximum left knee extension occurred during the back-swing in the BK group, in all other groups this occurred at mid-follow through. Other event timings were similar between groups. Lead knee axial rotation was reduced in BK and LK golfers who presented an average decrease in rotation of 5° and 10°, respectively. Discussion Golfers in all TKA groups demonstrated similar swing periods to those of the NK golfers. Groups exhibited similar timing in when golfers reached extremes of rotation. However, some variables presented a wide range of intra-subject variability. Results suggest the knee implant can provide a sufficient range of rotation to perform the golf swing. Significant differences were identified in bilateral knee-joint flexion between persons with unilateral or BK and NK golfers. However, the flexion range required is within the capabilities of the implant. This may indicate a reduction in knee flexibility in individuals who have had TKA or an unwillingness to load the knees fully. Axial rotation ranges observed in the NK golfers suggest that previous studies may have underestimated the range of rotation demanded of the knees when performing the golf swing. References Bradbury ND, Borton G, Spoo MJ. *American Journal of Sports Medicine* 26, 4 (1998): 530-35. Chatterji U. *ANZ J. Surgery* 75, 6 (2005): 405-8. Mallon WJ, Callaghan JJ. *Journal of Arthroplasty* 8, 3 (1993): 299-306.

**RELIABILITY AND CONSTRUCT VALIDITY OF VISUAL RATING OF POSTURAL ORIENTATION IN PEOPLE WITH OR WITHOUT MUSCULOSKELETAL DISORDER OF THE LOWER EXTREMITY – A SYSTEMATIC REVIEW**

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Background Clinical assessment of postural orientation (ability to stabilize body segments in relation to each other and the environment) by visual rating has increased during recent years. Rating the knee position relative to foot (knee abduction angle) is common. The evidence for reliability and construct validity of such assessment has yet to be examined. Aim To systematically review reliability and construct validity of visual rating of postural orientation in people with or without musculoskeletal disorders in the lower extremity. Methods A systematic review was conducted according to the PRISMA guidelines. Systematic searches were performed in Medline (PubMed), CINAHL and EMBASE (OVID) until January 8th 2015. Inclusion criteria were studies investigating reliability and/or construct validity of visual rating of Postural Orientation Errors (POEs) including 1) functional tasks placing demands on the lower extremity 2) men and/or women of any age with or without musculoskeletal disorder of the lower extremity. Results Forty studies were included. POEs were rated live and/or on video. The most commonly determined POEs were the knee medial to foot position (KMFP) ( $n=15$ ) and an overall score based on the orientation of several segments ( $n=48$ ). Inter-rater reliability ( $n=38$ ), intra-rater reliability ( $n=21$ ) and/or construct validity ( $n=14$ ) were evaluated. Reliability: The overall score ranged from moderate to almost perfect agreement in 71% and 86% of all cases for inter-rater ( $n=38$ ) and intra-rater reliability ( $n=22$ ), respectively (Intra Class Correlation (ICC), Kappa, first order agreement coefficient (AC1), 0.43-1.0). The KMFP ranged from substantial to almost perfect agreement in 61% and 67% of all cases for inter-rater ( $n=18$ ) and intra-rater reliability ( $n=9$ ), respectively (ICC, Kappa, AC1, 0.61-1.0). Construct validity: Eight studies validated visual rating of KMFP against 2D or 3D variables. A



greater knee abduction angle, or a greater hip internal rotation, was observed in people with a KMFP than in those without ( $p < 0.001$ ,  $n=2$ , and  $p < 0.049$ ,  $n=2$ , respectively). ROC analysis showed good discriminative ability of visual rating in people with or without KMFP (0.85-0.89,  $p < 0.002$ ,  $n=2$ ). Some high-risk athletes were missed with visual rating (sensitivity 46-87%,  $n=2$ ). Correlations showed moderate to good validity ( $r_s=0.54-0.6$ ,  $r_\rho=0.456$ ,  $k=0.85$ ,  $n=3$ ). Conclusions The overall score and the KMFP were reliable both within and between raters. Visual rating of KMFP seems to have acceptable validity for use in research and clinical practice. Validity for the overall score remains to be determined.

### **BODY CHARACTERISTICS OF PROFESSIONAL JAPANESE KEIRIN CYCLISTS: AN INVESTIGATION OF FLEXIBILITY, PELVIC TILT, AND MUSCLE STRENGTH**

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**INTRODUCTION:** Keirin is one of the track cycling sports. During cycling, body imbalances in the sagittal plane occur, because the trunk and hips are always in flexion. However, the body characteristics (e.g., flexibility, alignment, and muscle strength) of an athlete are not clear. Therefore, the purpose of this study was to investigate the musculoskeletal characteristics of Keirin cyclists. **METHODS:** Sixteen professional male, Japanese Keirin cyclists (mean age,  $32.2 \pm 8.6$  years) and a control group of 16 healthy men (mean age,  $24.3 \pm 2.3$  years) participated. We measured the subjects' pelvic tilt, straight leg raise (SLR) for flexibility of the hamstring, heel-buttock distance (HBD) for flexibility of the quadriceps, finger floor distance (FFD) for the trunk and lower limb flexibility, and hamstring quadriceps muscle strength ratio (H/Q ratio). Differences in the SLR, FFD, and HBD between the two groups were examined using analysis of covariance adjusted for age. The other parameters were compared using the unpaired t test. **RESULTS:** The pelvis of Keirin cyclists was significantly tilted anteriorly in comparison to that of healthy men ( $p < 0.01$ ). The SLR, FFD, and HBD of Keirin cyclists were significantly higher than that of healthy men adjusted for age. For muscle strength, the H/Q ratio of a high angular velocity was significantly greater in Keirin cyclists ( $p < 0.01$ ). **DISCUSSION:** Keirin cyclists have body imbalances in the sagittal plane, and their pelvis of tilts anteriorly in comparison to that of healthy men. We consider that this is caused by tight quadriceps and loose hamstrings. However, the H/Q ratio of high angular velocity is high in Keirin cyclists, and their hamstrings are more activated during high angular velocity than those of healthy men. **CONTACT:** tashiro.y@gmail.com

## **Mini-Orals**

### **MO-PM45 Real life threats to sport performance**

#### **FOLLOW-UP OF THE QUANTITY OF SLEEP OF 7 FEMALE GYMNASTS IN PREPARATION OF AND DURING THE WORLD CHAMPIONSHIPS ARTISTIC GYMNASTICS 2014**

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**Introduction** Sleep is considered to be one of the most important recuperation techniques for elite athletes in both training and competition periods[1][2]. However, little is known about the sleep pattern of elite gymnasts. The main goals of this study were (1) to identify the sleep pattern before and during competition and (2) to recognize the relationship between subjective sleep parameters and performance. **Methods** The Belgian team for the World Championships (WC) 2014 in Nanning, China, (7 elite female gymnasts,  $21.0 \pm 2.6$  years), took part in the study. They completed a daily sleep diary, starting in July until the end of the WC, with registration of the sleep quantity. Final ranking after the qualifications and mean apparatus score were set as objective performance measurements. The nonparametric Wilcoxon test was applied to detect variations in the sleep pattern. To identify the relationship between sleep duration, ranking and mean score, Spearman's rank correlation was used. A linear regression analysis determined the direction of relationship between these variables. **Results** Sleep duration the night before the podium training and the qualification ( $7:17 \pm 0:52$ ;  $7:10 \pm 1:38$ ) were shorter than the mean sleep duration during a baseline training week and during the WC ( $8:23 \pm 1:08$ ,  $p < 0.05$ ;  $8:36 \pm 0:35$ ,  $p < 0.05$ ). Gymnasts with a longer sleep duration, had a higher mean score at the WC ( $R=0.857$ ,  $p < 0.05$ ). Mean sleep duration predicted 64,1 percent of the variation in ranking ( $p < 0.05$ ) and 65,1 percent of the variation in mean score ( $p < 0.05$ ). **Discussion** The shorter sleep duration the night before the podium training and the qualification is in accordance with Erlacher et al. (2011) where 65,8 percent of athletes reported sleep problems the night prior to competition and whereby internal factors such as stress, were given as dominant causes. Sleep duration was least affected in female gymnasts with the best performance which may be due to better stress coping strategies or higher self-confidence. **References** 1. Fullagar HH, Skorski S, Duffield R, Hammes D, Coutts AJ, Meyer T: Sleep and Athletic Performance: The Effects of Sleep Loss on Exercise Performance, and Physiological and Cognitive Responses to Exercise. *Sports Med* 2014. 2. Halson SL: Sleep in elite athletes and nutritional interventions to enhance sleep. *Sports Med* 2014, 44 Suppl 1: S13-S23. 3. Erlacher D, Ehrlenspiel F, Adegbesan OA, El-Din HG: Sleep habits in German athletes before important competitions or games. *J Sports Sci* 2011, 29: 859-866.

#### **ACTIVE RECOVERY AND COLD-WATER IMMERSION ARE NOT SUPERIOR TO PASSIVE RESTING AFTER ECCENTRIC SQUAT EXERCISE**

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**Introduction** An appropriate balance between training or competition induced stress and recovery is an important factor for optimizing athlete's performance development. Beneficial recommendations for daily recovery routines are currently lacking, especially after bouts of resistance training. Therefore, the aim of this study was to determine the influence of active recovery (AR) and cold-water immersion (CWI) on different markers of fatigue after an eccentric enhanced squat protocol. **Methods** In a randomized repeated-measures design 13 physically active males (Age: 25,0 Years SD: 2,8 Years; Height: 182,9 cm SD: 3,5 cm; Weight: 82,0 kg SD: 6,1 kg) completed an eccentric enhanced squat protocol (six sets of six repetitions with 100% 1RM ecc. and 70% 1RM con.) followed by one of three 15-minute recovery

interventions in a counterbalanced order (i.e. AR, CWI, passive resting / PR). Performance (CMJ), muscle-contraction (Dm, V10 and V90), biochemical (CK) and psychological (DOMS) markers were measured pre-exercise, post-exercise, post-recovery, post 24h and post 48h. Results The squat protocol produced an acute significant ( $p \leq 0.05$ ) reduction in CMJ, Dm, V10 and V90 (post-exercise). Measured values remained decreased for 24 hours (Dm, V10 and V90), respectively 48 hours (CMJ). Concurrently, CK and DOMS raised significantly ( $p \leq 0.05$ ) post 24h. No differences in all markers of fatigue were found between AR, CWI and PR post 24h and post 48h. Additionally, post-hoc tests revealed that CWI led to a significant ( $p \leq 0.05$ ) decline in CMJ, V10 and V90 post-recovery in comparison to AR and PR. Discussion This data suggests that athlete's performance capacity is decreased for up to 48 hours after one bout of an eccentric enhanced squat exercise. Notably, none of the recovery interventions as applied in this study are able to contribute to a faster recovery during the first 48 hours compared to passive resting. On the one hand, this is in line with Goodall & Howatson (2008), but on the other Tufano et al. (2012) observed contrary results. Further, CWI leads to an acute decline of the jump performance and weakens the muscle contractile properties. This should be considered when using CWI between subsequent events at the same day. References Goodall S, Howatson G (2008). *J Sports Sci Med*, 7(2), 235-241. Tufano JJ, Brown LE, Coburn JW, Tsang KK, Cazas VL, LaPorta JW (2012). *J Strength Cond Res*, 26(10), 2777-2782. Contact alexander.doeweling@rub.de

### THE EFFECT OF DECEPTIVE INFORMATION ABOUT RECEIVING COOLING ON PACING PATTERN DURING A 20-KM CYCLING TIME TRIAL IN THE HEAT

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Introduction: Cooling during exercise in the heat has been shown to be beneficial for performance (Bongers et al. 2014), but it is still unclear to what extent this effect can be contributed to actual physiological or perceptual changes and to what extent the expectation of receiving cooling during cycling plays a role. Therefore, the aim of this study is to investigate the effect of false information about receiving cooling on performance and pacing pattern during a 20-km cycling time trial in the heat. Methods: 16 trained male participants performed three 20-km cycling time trials (TTs) in  $30.5 \pm 0.1^\circ\text{C}$  with  $45 \pm 3\%$  relative humidity. The first two TTs were with (WIND) or without (CONTROL) 4 m/s convective cooling during km 7-13. In the third TT, participants performed one of two trials in which they were deceived about receiving convective cooling during the TT. They either did not expect cooling during km 7-13 but did receive it (FALSE-NEG) or did expect cooling but did not get it (FALSE-POS). Power output (PO), heart rate (HR), rectal temperature (Tre), mean skin temperature (Tsk), thermal sensation (Tsens), thermal comfort (Tcomf), and RPE were measured. Results: During and after cooling, Tsk, Tsens, and Tcomf were lower in WIND than CONTROL, no differences were found in HR and Tre, and PO was lower during the entire TT in CONTROL than in WIND (239 vs. 251 W;  $P=0.02$ ). In FALSE-NEG, physiological parameters followed a pattern similar to CONTROL whereas pacing pattern prior to convective cooling was similar to CONTROL and during the cooling it was similar to WIND. After the cooling, no differences in pacing pattern were found between conditions. In FALSE-POS, no differences in pacing were observed despite higher Tsk, Tsens, and Tcomf. Discussion: Deceiving participants about the occurrence of convective cooling during self-paced exercise alters the pacing pattern of a 20-km cycling time trial in the heat. This shows the importance of expectations regarding thermal load in self-paced exercise. References: Bongers, C. C., Thijssen, D. H., Veltmeijer, M. T., Hopman, M.T., & Eijssvogels T. M. (2014). Precooling and percooling (cooling during exercise) both improve performance in the heat: a meta-analytical review. *British Journal of Sports Medicine*, doi:10.1136/bjsports-2013-092928. Batterham, A. M., & Hopkins, W. G. (2006). Making meaningful inferences about magnitudes. *International Journal of Sports Physiology and Performance*, 1(1), 50-57. Contact: k.levels@vu.nl

### HEATED GARMENTS AND DRYLAND ACTIVATION ROUTINES: THE KEYS TO IMPROVING SPRINT SWIMMING PERFORMANCE

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Introduction In competitive swimming after the pool warm-up, swimmers must change into their racing suit, confer with their coach and report to marshalling ~15-20 min prior to race start, thus transition phases of 30-45 min are not uncommon. There is a risk of a significant decline in body temperature with a long transition phase given that body temperatures can decline immediately following exercise cessation, with a significant reduction evident after ~15-20 min of recovery (Mohr et al., 2004). We postulate that this decline in body temperature during transition could be ameliorated by combining an athlete's sport-specific warm-up (i.e. pool warm-up) with passive heating and additional active warm-up strategies. Methods In a counterbalanced, repeated measures cross-over design 39 national and internationally competitive swimmers (age:  $20 \pm 2$  yr;  $n=19$  males: stature  $1.85 \pm 0.04$  m,  $79.4 \pm 6.4$  kg;  $n=20$  females:  $1.74 \pm 0.7$  m,  $65.6 \pm 6.3$  kg; mean  $\pm$  standard deviation) completed a standardised pool warm-up (1550 m) followed by a 30 min transition and a 100 m freestyle ( $n=29$ ) or breaststroke ( $n=10$ ) time-trial. Swimmers completed two different warm-up strategies during transition: CON, remained seated wearing a conventional tracksuit jacket and pants, or COMBO, wore an insulated tracksuit jacket (freestyle) or pants (breaststroke) with integrated heating elements and performed a 5 min dryland-based exercise routine. Swimming time-trial performance, core temperature, capillary blood lactate and lower-body power output were assessed. Time variables were normalised relative to the CON (control) condition. Results The COMBO warm-up yielded a  $0.30 \pm 0.19\%$ ; mean  $\pm$  90% confidence limits,  $p=0.04$  faster 100 m time-trial performance than CON. Start times to 15 m were also faster for COMBO ( $-0.10 \pm 0.06\%$ ,  $p=0.02$ ) compared to CON. Core temperature declined less ( $p=0.02$ ) during transition with COMBO ( $-0.27 \pm 0.08^\circ\text{C}$ ) than CON ( $-0.43 \pm 0.06^\circ\text{C}$ ). Lower-body peak power output immediately prior to time-trial commencement ( $p=0.89$ ) and post time-trial blood lactate concentration ( $p=0.66$ ) were not significantly different between conditions. Discussion Sprint swimming performance in national and international level swimmers can be substantially enhanced by combining a traditional pool-based warm-up with the application of heated garments, and the completion of a brief dryland-based exercise routine, during a lengthy transition phase. Attenuation of the decline in core temperature and an improvement in start time appear as the likely mechanisms responsible for faster time-trial performance. References Mohr M, Krusturup P, Nybo L et al. *Scand J Med Sci Sports* 2004, 14(3), 156-162. Contact Courtney.McGowan@canberra.edu.au

## Mini-Orals

### MO-PM31 Molecular Biology and Biochemistry: Molecular signaling/response

#### EXPRESSION OF MICRORNA-208B AND MYOSTATIN ARE INVERSELY CORRELATED, BOTH AFTER SPINAL CORD INJURY IN HUMANS AND IN RESPONSE TO OVEREXPRESSION IN VIVO IN RODENTS.

Boon, H., Sjögren, R.J.O., Massart, J., Egan, B., Kostovski, E., Iversen, P.O., Hjeltnes, N., Chibalin, A.V., Widegren, U., Zierath, J.R.

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Spinal cord injury in humans is characterised by marked skeletal muscle atrophy and fiber type transformation towards fast, type II, fibers. MicroRNAs are short, non-coding RNAs that fine-tune target expression through mRNA degradation or by inhibiting protein translation. Intronic to the slow muscle fiber type genes MYH7 and MYH7b, microRNA-208b and microRNA-499-5p are hypothesized to fine-tune expression of genes important for muscle growth, such as myostatin. Here, we investigated the skeletal muscle expression of microRNA-208b, microRNA-499-5p and myostatin in humans after complete cervical spinal cord injury, as well the regulation of myostatin expression by these microRNAs in rodents. A progressive decline in microRNA-208b and -499-5p expression was observed in humans during the first year after spinal cord injury. Expression levels were further downregulated after long-standing injury. Gene expression of myostatin was inversely correlated with microRNA-208b and -499-5p expression. Electroporation of microRNA-208b in mouse skeletal muscle directly decreased myostatin gene expression. In conclusion, expression of microRNA-208b and its previously validated target myostatin are inversely related, both in atrophic skeletal muscle from humans after spinal cord injury, as well as following overexpression in rodent muscle. Our results provide evidence for a role of microRNA-208b and myostatin in regulation of skeletal muscle mass after spinal cord injury.

#### CHRONIC ADAPTATION OF BLOOD CELLS TO TRAINING IN INTERMITTENT, COMBAT AND ENDURANCE PLAYERS

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Chronic adaptation of blood cells to training in intermittent, combat and endurance players Sports Authority of India, India Introduction: Acute responses of blood cells to training are evidenced by numerous studies (2, 6). Our present study is to find out the chronic response of blood cells of athletes who were in 5-7 years of training. Methods: Thirty nine hockey, 37 kabaddi and 17 waterpolo male players were volunteered as subjects with the training age of 5-7 years. Venous sample was collected in EDTA tube after an overnight fast and analyzed white blood cell (WBC), platelet, lymphocytes, neutrophils in players by Sysmex pochH100i. Statistics was done by the software MINITAB14. Results: The mean value of WBC ( $\times 10^3/\mu\text{L}$ ), Platelet ( $\times 10^3/\mu\text{L}$ ), neutrophil (%) is significantly high in waterpolo players 8.582, 271.18 and 63.17 than the hockey (6.221, 235.59, 46.68) and kabaddi players (6.962, 259.14, 53.39) respectively. The mean value of lymphocyte (%) is significantly low in waterpolo players (27.72) than the hockey (41.56) and kabaddi (33.11) players. Discussion: Training athletes differs according to the physiological demand of the game. The energy contribution in waterpolo is 60% aerobic, 40% anaerobic, hockey (50% aerobic, 50% anaerobic), kabaddi, being an indigenous game introduced in the Asian games in the year 1990 (55% aerobic, 35% anaerobic system) (Khanna et al., 1996). The mean value of WBC, platelet and neutrophil are significantly higher in waterpolo due to the long term (5-7 years) in high amount of aerobic training. Chronic adaptation of aerobic training, hormones (growth hormone and catecholamine) increases the cytokines TNF- $\alpha$ , IL-1, IL-4, IL-6 that in turn increased the WBC, neutrophil and platelet in waterpolo players. Lowest count of lymphocytes in waterpolo may be due to the mobilization of more neutrophil from bone marrow to blood and the egress of lymphocytes from the blood to the tissue. Literatures evidenced that the cortisol level is more in endurance game which results in low lymphocyte count of waterpolo players. Cortisol inhibits lymphocyte proliferation and activation by directly inhibiting IL-2 and IL-2 receptor production (Cohen et al., 1991). Alterations in gene expression in skeletal muscle adaptation to endurance training are correlated to changes in blood cell gene expression viz PDGFRB, EREG, MIP-1 $\alpha$ , MIP-1 $\beta$ , HSP70, DUSP1 which in turn increases the circulating level of WBC, platelet and neutrophil (Connolly et al., 2004, Zeibig et al., 2005). References: 1. Cohen JJ (1991). *Adv Immunol*, 50, 55-85. 2. Connolly PH, Caiozzo VJ, Zaldivar F, Nemet D, Larson J, Hung S, Heck JD, Hatfield GW, Cooper DM (2004). *J Appl Physiol*, 97, 1461-1469. 3. Khanna GL, Majumdar P, Malik V, Vrinda T, Mandal M (1996). *Br J Sports Med*, 30(3), 232-235. 4. Zeibig J, Karlic H, Lohninger A, Damsgaard R, Smekal G (2005). *Eur J Appl Physiol*, 95, 96-104.

#### SPORTOMICS ANALYSIS OF METABOLIC RESPONSES IN OLYMPIAN RUNNERS USING A 100M DASH RACE AS A MODEL

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Introduction The 100m dash is the fastest race in the Athletics Olympic program. This exercise requests an important ATP hydrolysis and regeneration. Due to its high intensity and short duration, followed by rest, this race is extremely useful to study the blood kinetics of some metabolites in high energetic demand. Sportomics is a field of study combining "-omics" sciences with classical biochemical analyses in order to understand sports induced systemic changes (Bassini and Cameron, 2008). Sportomics deals with real in-field athletic conditions and allows us to make personalized training adaptations based on both cellular and systemic biochemical changes. In this paper, we compare Sportomics findings during a 100m dash race to describe metabolic responses of two top-level sprinters. Methods Two world-class female athletes were evaluated during a 100m-dash training test. We collected 6 blood samples: at fasting; pre-race (T1); immediately post-race (T2); and after 2, 5, and 10 min (respectively T3, T4 and T5) recovery. For this study we analyzed nearly 40 blood parameters in order to understand the different personal responses to exercise. Results Hematocrit levels increased in response to exercise from approximately 2 or 6 % normalized at T1 for each athlete. The lactate kinetics curve was quite similar for both athletes, reaching a plateau at T2 and maintaining this level until T5. While athlete 1 had an increase in lactate concentration of ~275 % (3.9 - 14.9 mmol/L), athlete 2 was near ~800 % (1.8 - 16.0 mmol/L). Ammonia response in athlete 1 has two big slopes (T1 - T2 and T3 - T4), peaking at 130  $\mu\text{mol/L}$  (250 %) and 148  $\mu\text{mol/L}$  (315 %) decreasing to 90  $\mu\text{mol/L}$  at T5. In contrast, a single component was measured for the second athlete, with concentration at T2 (540 %; 205  $\mu\text{mol/L}$ ), maintaining a plateau from T3 to T5 around 135  $\mu\text{mol/L}$  (320 %). Blood creatinine concentration followed the same kinetics from T1 to T3 in both athletes, raising 8 - 9 %. The general response was similar in T4 and T5 as well, but

absolute values varied in athlete 1 (1.0 to 1.1 mg/dL) when compared to athlete 2 (1.4 to 1.5 mg/dL). Discussion Even though we are dealing with two elite athletes of the same team, exposed to the same training experiences and competition routines, their metabolic answers were quite different in some parameters as previously described by us (Bassini-Cameron et al., 2008). This analysis allows us to infer that the difference of metabolic responses to the exercise of both athletes is due to a bigger ATP storage in the muscle or to lower bioenergetics efficiency. References Bassini A, Cameron LC. *Biochem Biophys Res Commun*, 2008 443, 800. Bassini-Cameron et al. *Br J Sports Med*. 2008 42(4):260-6. Contact cameron@unirio.br

## TWELVE WEEKS OF UNCOMPLICATED RESISTANCE TRAINING INCREASES LEAN BODY MASS AND REDUCES MARKERS OF MUSCLE ATROPHY IN OLDER ADULTS

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**Introduction** Resistance exercise is an established countermeasure to attenuate the decline in lean body mass (LBM) that occurs with aging, but the effects of resistance exercise training on markers of muscle atrophy in older adults is not well-described. The aim of the present study was to investigate the effects of twelve weeks of 'uncomplicated' resistance exercise training on LBM and markers of muscle atrophy in older adults. **Methods** Thirty-nine medically-stable, free-living older adults were randomised to either resistance exercise training (REX, n=21; age, 63.9±4.1 y; body mass index, 25.2±2.5 kg m<sup>-2</sup>) or non-training control (CON, n=18; 63.1±4.8 y; 26.7±2.9 kg m<sup>-2</sup>) for a 12 week intervention. REX consisted of three supervised exercise sessions per week, each lasting 45 minutes and consisting of uncomplicated resistance exercises predominantly in the form of bodyweight and resistance band exercises. Physical function including 10 m walking test and chair raise tests was assessed before and after the intervention. Muscle biopsies from the vastus lateralis were taken prior to commencing training and at 60 h after the final training session. Changes in transcript abundance for molecular markers of fibre type and muscle atrophy were assessed by quantitative polymerase chain reaction (qPCR). Results REX resulted in an increase in whole-body LBM (0.93±0.83 kg; p<0.001) and leg LBM (0.25±0.27 kg; p=0.001), which were unchanged in CON. Improvements in 10 m walking test and chair raise tests (reps in 30 sec and time for 5 reps) were observed in REX (all p<0.05), but not CON. Relative mRNA expression of FOXO3 was decreased (30%; p<0.05), MAFbx tended to be decreased (24%; p=0.077), and MYOD was decreased (38%; p<0.01) after REX, but myostatin was unchanged. Myosin heavy chain isoform expression was decreased for type I (40%; p<0.01) and type IIX (48%; p<0.05) and increased for type IIA (43%; p<0.001) muscle after REX. **Discussion** The present study describes a REX training intervention of bodyweight- and resistance band-based exercises for older adults, which demonstrates efficacy to increase LBM and physical function in this population. Increases in LBM coincided with reductions in markers of muscle atrophy and elevated expression of type IIX muscle fibres. Future work will explore markers of muscle protein synthesis in these samples. **Acknowledgements** This work supported by funding from Enterprise Ireland and Food for Health, Ireland. Correspondence brendan.egan@ucd.ie

## IMPACT OF ACE I/D POLYMORPHISM ON HEART RATE VARIABILITY AFTER 10 WEEKS OF AEROBIC TRAINING IN CHILDREN

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**Introduction** Heart rate variability (HRV) has important cardio-protective effects and is modulated by physical training. Likewise, the renin-angiotensin system interacts with the autonomic nervous system and the angiotensin-converting enzyme (ACE) is suggested to have a genetic variability that exerts considerable influence on HRV (Thayer et al., 2003). However, no data are available regarding the genetic determinants of HRV responsiveness to training in pediatric populations. Thus, the purpose of this study was to test the impact of ACE I/D polymorphism on resting HRV after 10 weeks of physical training in pre-pubertal children. **Methods** Eighty-four children (44 male and 40 female) between 8 and 9 years old (Tanner 1) took part in this study. They were assigned to a 10-week running training program (3 times per week for 40 min per session; intensity >80% of maximal aerobic velocity). To investigate the effects of different ACE polymorphisms on HRV responses to training, the participants were assigned to three distinct groups (ID, II and DD) based on their ACE gene I/D genotype. For ACE genotyping, DNA was isolated from saliva samples and subjected to polymerase chain reaction (PCR) followed by polyacrylamide gel electrophoresis (SDS-PAGE). Resting heart rate was obtained during 10 min in a supine position (Polar RS800) and HRV was measured using spectral and time domain analysis. The groups (ID, II and DD) versus time (pre HRV x post HRV 10 weeks) comparisons were performed using two-way ANOVA with repeated measure analyses. Results Of the 84 children, 46 presented the ID genotype; 21, the II and 17, the DD. After training, all groups demonstrated enhanced HRV parameters compared to baseline. However, ACE DD homozygotes demonstrated significantly lower values (P<0.05) pre training for SDNN, RMSSD and SD1 (28.8±8.6 ms; 21.7±6.0 ms and 15.5 ± 4.3 ms) when compared with ACE ID (42.5 ± 12.8 ms; 42.5 ± 12.8 ms and 29.8 ± 11.3 ms) and ACE II (29.8 ± 11.3 ms; 29.8±11.3 ms and 29.3 ± 16.7 ms, respectively). Furthermore, the ACE DD demonstrated significantly higher (P<0.05) LF (nu) values (60.5 ± 9.8) pre training, compared to ID (54.2 ± 14.4). **Discussion** It is recognized that homozygous DD allele have higher angiotensin II levels which elicit vasoconstriction and consequently higher blood pressure and lower HRV (Thayer et al., 2003). Our results corroborated these findings and demonstrated that homozygous DD allele demonstrated significantly lower HRV with respect to their II/ID counterparts pre-training. However, independent of ACE I/D genotype, a 10 week running training program provoked improvements in vagal-related indices (RMSSD and SD1), in addition to enhancing SDNN in all the ACE I/D polymorphism groups. References Thayer JF; Merritt MM, Sollers JJ, Zonderman AB, Evans MK, Yie S, Abernethy DR. (2003). *Am J Cardiol*, 92:1487-1490.

## DEVELOPMENT OF THE ATHLETES RECRUITING SYSTEM IN CYCLIC SPORTS BASED ON INDIVIDUAL MORPHOFUNCTIONAL AND GENETICS PARAMETERS

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**INTRODUCTION** Modern approaches to the sportsmen recruitment and individualization of the training process should take into account both genetic and environmental factors contribution to the making of the world-class athlete. The aim of this study was to develop a genetic monitoring program to determine the individual profile for athletes reserve in cyclic sports. **METHODS** The study group comprised 250 swimmers, both males and females, aged 10-19. We evaluated the morpho-functional state of swimmers using morphological and functional suitability scales (Davydov V.Y. et al.). Genotyping and frequency of 5HTT, ACE, AGT, PPARA, PPARG, PPARGC1A, and TFAM polymorphisms were obtained by site-specific PCR amplification that was performed on genomic DNA isolated from buccal epithelial

cells (Akhmetov I.I.). RESULTS The morphofunctional state evaluation showed that most of the athletes had 'average' (66.7% total; 62.2% in girls; 69.7% in boys) and 'above average' morphophysiological level (21.6% total; 24.4% in girls; 21.6% in boys). 9.0% of the study group had 'below the average' level (8.9% in girls; 9.1% in boys), and only 2.7% had 'high level' (4.5%; and 1.5%). The prevalence of the following genotypes was discovered: AGT CC (77.78%±5.66% in boys; 73.17%±6.92% in girls), PPARA GG (65.38%±6.60%; 70%±7.25%) TFAM GG (59.62%±6.80%; 53.66%±7.79%), PPARD TT (58.82%±6.90%; 70%±7.25%). These genotype frequencies were significantly higher than in controls. There was also significant difference of the distribution of the ACE ID in boys (24.53%±5.91%) and girls (46.34%±7.79%), and ACE II in study group (22.64%±6.15% in boys vs. 14.63%±5.52% in girls); the frequency of the TFAM GC was also significantly higher in girls (31.71%±7.27% vs. 13.46%±4.73%). We also observed the trend in PPARD TT genotype distribution (70%±7.25% in girls vs. 58.82%±6.90% in boys). DISCUSSION Conducted anthropological examination allowed to develop the model parameters of morphological and functional parameters of the athletes. We analyzed the morphophysiological developmental level based of these characteristics and evaluated maximum potential taking into account so called 'testosterone peak'. The most promising athletes were observed in groups of 14 and 15 years (girls) and 11 and 15 years (boys). On the basis of previous studies we selected 5 candidate genes and studied a common genetic profile of the swimmers. As a result, the basic polymorphic genes set for subsequent screening study was developed. Thus, AGT C, PPARA G, PPARD T and TFAM G alleles can be considered as relevant genetic markers for swimmers. After initial screening examination of these genetic markers further molecular genetic testing for the 13 gene polymorphism will be carried out. References Akhmetov I.I. Molecular genetics of sports: a monograph. – M.: Soviet Sport, 2009. – 268 p. (RUS) Davydov VY Selection and orientation of swimmers in terms of physique in the long-term training (theoretical and practical aspects): monograph / Davydov VY, Avdienko VB. (2013). – M.: Soviet Sport, 2013. – 384 p. (RUS)

### EPIGENETIC CHANGES WITHIN THE ADAMTS4 GENE PROMOTER MAY MODIFY RISK OF PATELLA TENDINOPATHY.

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Introduction Patellar tendinopathy (PT) is common in sports involving jumping where it represents more than 30% of knee injuries (Christian et al, 2014). Genetic factors are known to increase the risk of other tendinopathies (Raleigh and Collins, 2012) but the role of epigenetics in overuse injuries has never been described. Epigenetic modification, such as the methylation of DNA CpG sites, alters gene expression and is likely to impact on performance phenotypes (Raleigh, 2012). Indeed, DNA methylation plays an important role in disease processes and represents a promising avenue of research in tendinopathy. Accordingly, the aims of this study were to identify whether the DNA methylation status of two genes (ADAMTS4 and TIMP2) known to be involved in the tendinopathic process (Corps et al, 2008; El Khoury et al, 2013) were altered in tissue collected from those with PT compared to controls. Methods Twenty (10 PT and 10 healthy controls) male patellar tendon samples were collected for this study. The DNA methylation status of 6 ADAMTS4 and 4 TIMP2 CpG sites from within the respective promoters were determined in all samples using next generation sequencing (NGS). Data were analysed using a t-test and significance was set at  $p < 0.05$ . All procedures were approved by the relevant research ethics committees. Results There were no significant differences in mean methylation profiles for both the ADAMTS4 ( $p = 0.294$ ) and TIMP2 ( $p = 0.885$ ) gene promoter regions between PT and controls. However, a specific site within an important regulatory region of the ADAMTS4 promoter was hypermethylated in the PT group ( $p = 0.016$ ) compared to controls. Discussion This is the first study to focus on epigenetics as a possible determinant of tendinopathy. Although mean DNA methylation levels for both the ADAMTS4 and TIMP2 promoters were not altered, the hypermethylation of a single CpG site with the ADAMTS4 promoter between PT and the control groups may be functionally important. This area of the ADAMTS4 promoter is known to be important for its regulation (Thirunavukkarasu et al, 2006). Our investigation did not cover all of the CpG sites within the promoter regions studied. Ongoing work within our laboratory continues to investigate the epigenetic basis of soft tissue pathologies related to sports and physical activity. Christian RA, Rossy WH, Sherman OH. Bull Hosp Jt Dis (2013). 2014;72(3):217-24 Raleigh SM and Collins M (2012). Achilles Tendon. InTech. pp. 25-40. Raleigh SM (2012). J Appl Physiol (1985) 112(6):1082-3 El Khoury L, Posthumus M, Collins M, Handley CJ, Cook J, Raleigh SM (2013). J Sci Med Sport. (6):493-8 Corps AN, Jones GC, Harrall RL, Curry VA, Hazleman BL, Riley GP (2008). Matrix Biol. 27(5):393-401 Thirunavukkarasu K, Pei Y, Moore TL, Wang H, Yu XP, Geiser AG, Chandrasekhar (2006). Biochem Biophys Res Commun. 2006;345(1):197-204

## Mini-Orals

### MO-PM33 Neuromuscular Physiology: Fatigue

#### H-WAVE AMPLITUDE FLUCTUATION IS ASSOCIATED WITH VARIATION OF MAXIMAL VOLUNTARY MUSCLE CONTRACTION WITHIN A SUBJECT

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Introduction Unexpected kinetic errors in repeated body motions always happen in competitive athletes. Even in a maximal voluntary muscle contraction (MVC) in the laboratory testing, the subject often experiences the failure of maximal effort, i.e., the fluctuation of the peak force between the MVC trials; while its detailed mechanism remains to be elucidated. A previous study (Nozaki et al., 1995) showed the time-series variation of H-wave amplitude in soleus muscle (SOL), which reflects the input-output characteristics of the  $\alpha$  motor neuron ( $\alpha$ MN) pool. These observations led us hypothesize that the fluctuation of the  $\alpha$ MN excitability influences the variation of the MVC. The aim of this study was therefore to assess effect of the variation in  $\alpha$ MN excitability on the MVC fluctuation. Methods The subjects were 11 healthy men (21-31 yrs). Surface EMG was recorded from each of the medial and lateral gastrocnemius muscles (MG and LG) and SOL. Each subject repeated 2-s isometric MVC of plantar flexors ten times with sufficient rests (>2min), while the average amplitude of three H-waves was recorded in each muscle during 2-5s before each MVC trial. For each MVC trial, the EMG RMS value (1-s window) at peak force was computed in each muscle. For each muscle, the ten MVC trials were ranked according to the greatness of the muscle's EMG RMS value, and we defined the upper and lower three MVC trials as successful and failed trials, respectively, of the muscle. The averages of EMG RMS and H-wave amplitude were calculated for the successful and failed trials for each muscle in each subject. Results and Discussion There was no significant difference between the average trial numbers which induced successful and failed trials, in each muscle (N.S.). The average of EMG RMS value in the successful trials across subjects was significantly larger than that in the failed trials, in

each muscle ( $P < 0.01$ ). Also, the average of H-wave amplitude in the successful trials was significantly larger than that in the failed trials in MG ( $P < 0.05$ ). In contrast, in the relative change of H-reflex amplitude, significant correlations among subjects were found between SOL and LG at the successful ( $r = 0.98$ ,  $P < 0.01$ ) and failed ( $r = 0.77$ ,  $P < 0.05$ ) trials, while no significant correlation was found as for MG. These results indicate that there existed the substantial variability in the motor output in each muscle between the repeated MVC trials, and, in MG, the fluctuation of muscle output was associated with that of input-output characteristics of  $\alpha$ MN. On the other hand, LG and SOL might have different mechanisms. References Nozaki D, Nakazawa K, Yamamoto Y.(1995). *Exp Brain Res*,105(3), 402-410. Contact sh0011kk@ed.ritsumei.ac.jp

### HOW MANY SETS OF SUBMAXIMAL CONSTANT-TORQUE PASSIVE STRETCH ARE NECESSARY TO REDUCE PLANTAR FLEXOR PASSIVE TENSION?

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**Introduction:** Passive muscle stretching is commonly used in pre-exercise preparatory routines with the aim of decreasing muscle-tendon unit (MTU) passive tension and consequently increasing joint range of motion during physical activity and clinical rehabilitation training. It has been clearly demonstrated that passive stretch can reduce passive tension in the plantar flexors, however the majority of the studies investigating changes in passive tension after passive stretch have imposed constant-angle stretches while standard stretching practices are more similar to a submaximal constant-torque stretch design. To the best of our knowledge there is a lack of data in the literature reporting the dose-dependent response to submaximal constant-torque stretches. Thus, the purpose of the present study was to investigate the dose response of MTU passive tension to a series of submaximal constant-torque plantar flexor stretches to provide information as to the optimum stretch dose. **Methods:** Fifteen men performed four 1-min stretches with a 15-s inter-stretch rest interval after a warm-up. The stretches were performed as a constant-torque ankle stretch on an isokinetic dynamometer. The intensity of stretch was set as 90% of maximal tolerable torque measured during a maximal passive stretch in a familiarisation session. Passive torque was measured at 5°, 10° and 15° while the isokinetic dynamometer passively rotated the ankle into dorsiflexion on. A two-way repeated measures ANOVA was used to compare passive tension measured at 5°, 10° and 15° between stretches 1 - 4. **Results:** There was a significant angle  $\times$  stretch interaction effect ( $p = 0.001$ ). Post-hoc analysis revealed that passive torque was reduced by ~8% at the three angles after the first 1-min stretch. Passive torque was further reduced by 11 and 13% at 10° and 15°, respectively, after the second stretch. No further reductions were observed after the third stretch. **Discussion:** A single submaximal, constant-torque plantar flexor stretch significantly reduced passive torque at all three angles; the magnitude of this reduction is likely to be clinically/functionally relevant. However, two 1-min stretches induced a greater reduction in passive torque at the greater dorsiflexion angles, but continued stretching did not cause any additional reduction. These results suggest that there is a dose-response relationship between stretch volume and the reduction in passive tension in the plantar flexor group where two 1-min stretches seem to be optimal to reduce passive torque. Further research using different stretch intensities and durations would possibly allow for more detail to be gained with respect to the optimum dose of static stretching. Contact gabrieltrajano@gmail.com

### NEUROMUSCULAR CHARACTERISTICS OF QUADRICEPS AND HAMSTRINGS MUSCLES DURING A SOCCER MATCH.

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**INTRODUCTION:** To investigate the EMG activity of quadriceps and hamstrings muscles in the first (PRE) and last 15 minutes (POST) of a soccer match and to determine the player's neuromuscular activity profile using burst analysis method during an entire match. **METHODS:** Seven professional players, 1 left-footed and 6 right-footed, playing the highest Finnish soccer league volunteered (age  $23.1 \pm 6.1$  y; height  $1.82 \pm 5.2$  m; mass  $78.4 \pm 10$  kg). EMG from left and right quadriceps (LQ, RQ) and hamstrings (LH, RH) were measured, maximal voluntary contraction (MVC) during knee extension and flexion were assessed before the match. Muscle light, moderate and vigorous activities were defined as EMG value during treadmill running at 6, 12 and 16 km/h, respectively. Muscle inactivity threshold was defined as EMG value below 2% of EMGMVC (Tikkanen et al. 2013). After artifact removal, raw EMG data were rectified and ran through a Matlab algorithm, which normalized the EMG to EMGMVC and provided the distribution of muscle inactivity and activity at different percentage of EMGMVC. Burst analysis provided average EMG (aEMG), number of bursts, duration of bursts, burst amplitude, burst rate/seconds. Wilcoxon signed rank test with significance level of  $p < 0.05^*$  was applied. **RESULTS:** Compared to PRE, aEMG in the final 15 minutes of the match showed a significant decrease for RQ (27%), RH (29%) and LH (18 %). Burst duration revealed a significant decrease of 31% for RH, 22% for LQ and increase of 29% for LH. Burst amplitude was decreased by 23% for RQ and 20% for RH. RQ burst rate decreased by 20%. Inactivity time increased by 10% for LQ and 35% for LH. RQ light activity increased by 6%. Moderate activity time decreased for RH (17%) and LH (23%). Finally, vigorous activity reduced significantly for RQ (31%), RH (37%) and LH (27%). **DISCUSSION:** For the first time, this study reports a muscle EMG activity measured during an actual soccer match. As expected, EMG activity was reduced and the players spent more time at lowest intensities compared to highest intensities in the final 15 minutes. Rahnama et al (2006), showed similar EMG results when exercising at match-like intensity. Our study revealed greater muscle activities for dominant than for non-dominant leg. While care should be taken when interpreting the EMG signal amplitude, our results give an interesting starting point for using EMG as a monitoring and measurement tool for performance evaluation and prevention of soccer injuries. **REFERENCES** 1. Rahnama, N., Reilly T. & Lees, A. 2006. Electromyography of selected lower limb muscles fatigued by exercise at the intensity of soccer match-play. *J Electromyogr Kinesiol* 16, 257-263. 2. Tikkanen, O, Haakana, P, Pesola, A, Häkkinen, K, Rantalainen, T, Havu, M, Pullinen, T, Finni, T. 2013. Muscle activity and inactivity periods during normal daily life. *PLoS One* 8(1):e52228

### THE ETIOLOGY OF ELECTROSTIMULATION-INDUCED MUSCLE FATIGUE IS RELATED TO THE MODULATION OF STIMULATION PARAMETERS

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**Introduction:** Neuromuscular electrical stimulation (ES) applied with high frequency and wide pulse (WPHF) results in greater force loss than short-pulse-low-frequency ES protocols (CONV) (1). This greater fatigue development has been related to a higher metabolic cost per activated motor units (MUs) for high than low stimulation frequency (2). However, a reduction of the amount of solicited MUs linked to a higher stimulation frequency could also be involved (3). In the present study we combined electrophysiological and metabolic measure-

ments in order to characterize the impact of ES parameters on the etiology of muscle fatigue. Methods: Eleven healthy subjects completed both WPHF (80Hz-1ms) and CONV (20Hz-50 $\mu$ s) protocols for two testing sessions. The triceps surae muscle (TS) was electrostimulated through the tibial nerve at an intensity evoking 20% of maximal voluntary contraction (Istim) for 40 trains (6s on- 6s off). During the first session, force-frequency relation (F(Hz)) were established at Istim before and after each protocol in order to assess the contractile properties of the solicited MUs. For both protocols, a single twitch was delivered at Istim after each train. Force and electromyographic activity (EMG) of the TS were continuously recorded. M-wave EMG responses were assessed to provide an index of the amount of solicited MUs during each protocol. During the second experiment, subjects were supine with the right leg centered within a 3T magnet. Changes in concentrations of phosphocreatine (PCr) and intracellular pH were assessed during each protocol using <sup>31</sup>P-MR spectroscopy. Results: A similar decrease in force was observed for both protocols. The CONV protocol induced a force reduction at all stimulation frequencies of the F(Hz) ( $P < 0.05$ ) leading to a rightward shift of F(Hz). On the contrary, a significant reduction of the TS M-wave amplitude evoked at Istim was only observed for the WPHF protocol. This decline was positively correlated with the ES force decrease ( $R = 0.96$ ,  $P < 0.001$ ). Both changes in PCr and pH were similar for the two protocols. Discussion: We showed that the magnitude of force loss and metabolic changes were similar for both protocols. However, the etiology of the muscle fatigue was strongly related to the ES parameters. Indeed, WPHF-induced fatigue was related to changes in axonal excitability threshold leading to a lower amount of solicited MUs whereas intramuscular processes (i.e., at the cross-bridges level) are likely to be involved during CONV protocol. (1)Neyroud et al. *J Appl Physiol* 2014; 116: 1281-9 (2)Russ et al. *Am J Physiol End Met* 282; 448-457 (3)Papaioannidou et al. *Muscle & Nerve* 2014; 50: 604-7

### EMG RESPONSES OF POWER PRODUCER AND POWER TRANSMITTER MUSCLES DURING A FATIGUING CYCLING EXERCISE

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Introduction In various sports, the performance produced by athletes depends on their ability to maintain high levels of power output by regulating the contribution of their muscles. Dorel et al (2009) reported that towards the end of a time-to-failure (TTF) cycling exercise, athletes may increase the EMG activity of the hip extensor muscles to compensate for the loss of force of knee extensors. The aim of this study was to determine if changes in the EMG of the lower limb muscles vary depending on their functional role (Zajac et al., 2002) during a TTF cycling exercise. Methods Ten males completed a Torque-Velocity (T-V) test followed by a TTF cycling exercise performed at 110% VO<sub>2</sub>max and stopped when power fell below 105% VO<sub>2</sub>max. Crank torque, cadence and power output were measured using SRM cranks while surface EMG signals of 7 muscles [gluteus maximus (GMAX), rectus femoris (RF), vastus lateralis and medialis (VAS), tibialis anterior (TA), soleus (SOL), and gastrocnemius (GAS)] were recorded. Results from the T-V test were used to calculate relative levels of power (Gardner et al., 2009) and EMG (Rouffet & Hautier, 2008) during two intervals of the TTF: Int5-10%, and Int95-100%. Finally, the EMG responses of the muscles were analysed by considering separately power producer muscles (PP): GMAX, RF and VAS and power transmitter muscles (PT): TA, SOL and GAS. A two-way ANOVA (time interval x muscle group) with repeated measures was used for analysing EMG responses. Results Power output fell below 105% VO<sub>2</sub>max after 193 $\pm$ 74s and was lower during Int95-100% (309 $\pm$ 52W vs. 284 $\pm$ 53W;  $p < 0.05$ ). However, no changes were observed for the relative level of power (37 $\pm$ 9% vs. 36 $\pm$ 8%;  $p = 0.13$ ) and EMG activity of the 7 muscles (30 $\pm$ 2% vs. 27 $\pm$ 3%;  $p = 0.20$ ) measured during the first and last time intervals. A muscle group\*interval effect was seen on the EMG responses: EMG activity of PP muscles increased (28 $\pm$ 7% vs. 36 $\pm$ 12%;  $p < 0.05$ ) while EMG activity of PT muscles decreased (34 $\pm$ 7% vs. 29 $\pm$ 10%;  $p < 0.05$ ) between the first and last intervals. Discussion The adjustments of the EMG of the lower limb muscles differed from those previously reported during a comparable TTF cycling exercise (Dorel et al., 2009). Our EMG results suggest the occurrence of peripheral fatigue in PP muscles (including both knee and hip extensors) with a reduction in the demand placed on the PT muscles and/or the occurrence of central fatigue in PT muscles at the end of the TTF cycling exercise. References Dorel S, Drouet J, Couturier A, Champoux Y, Hug F. (2009). *Med Sci Sport Exerc*, 41(6), 1277-1286. Gardner A, Martin D, Jenkins D, Dyer I, Van Eijden J, Martin J. (2009). *Med Sci Sport Exerc*, 41(4), 904-911. Rouffet D, Hautier C. (2008). *J Electromyogr Kines*, 18, 866-878. Zajac F, Neptune R, Kautz S. (2002). *Gait Posture*, 16, 215-232. Contact david.rouffet@vu.edu.au

### EFFECTS OF UPHILL WALKING AND DOWNHILL WALKING ON POSTURAL CONTROL

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Introduction Finding risk factors for stumbles and falls is a major topic in accident prevention. Mountain hikers as well as elderly people are claimed to step precisely and to control posture to minimize risk of falling. Balance performance is impaired after fatiguing exercise (Helbostad et al., 2010). The aim of this study is to compare postural control after exercise without fatigue and to compare effects of uphill and downhill walking. Methods 12 well trained young male students (mean age 27y, SD 2y) took part in this study. Postural control was checked with MFT S3 check (Raschner et al., 2008) where participants had to keep at level a platform tilting in anterior-posterior or medial-lateral direction while standing on it. Postural control was measured before and after a 20 min walk on a treadmill (uphill – speed 3km/h, or downhill, both 20% tilt) in a cross over design. The speed of downhill walking was adapted to leg length. Every five minutes the heart rate and the mental state by a Borg-scale (6-20) were recorded. ANOVA with repeated measures was conducted, level of significance was set on 0.05. Results Heart rate was significantly higher in uphill walking while the work load was felt similar. Borg scale values (about 13) were slightly but not significantly higher for downhill walking. Balance scores in the anterior-posterior direction after walking were significantly higher (=worse) than before walking ( $F(1,11) = 6.5$ ,  $p = 0.027$ ,  $\eta^2 = 0.37$ ). There was no difference in the deterioration of balance after uphill compared to downhill walking. Balance scores in the medial-lateral direction were unaffected. Discussion Balance performance on a tilting platform was negatively affected after treadmill walking only in the anterior-posterior direction. This might be due to the deterioration of the joint position sense (Bottoni et al., 2014). In our study participants were not fatigued (Borg scale 12-14). While the control of movements in the medial-lateral direction seems to be the same over all exercises, the balance control of the platform tilting in the anterior-posterior direction demands activity of the knee and ankle muscles highly involved in walking. Because of the fact that the participants were not fatigued after the exercises further studies should focus on adaptation strategies of perceptual information for postural control. References Bottoni G, Heinrich D, Koffler P, Hasler M, Nachbauer W. (2014). *J Sport Rehabil*, Oct. 29 [Epub ahead of print]. Helbostad J, Sturnieks D, Menant J, Delbaere K, Lord S, Pijnappels M. (2010). *BMC Geriatr* Aug 17; 10:56. Raschner C, Lember S, Platzer H, Patterson C, Hilden T, Lutz M. (2008). *Sportverletz Sportschaden* 22(2):100-105. Contact inge.werner@uibk.ac.at

## EFFECTS OF DIETARY NITRATE SUPPLEMENTATION ON LOW-FREQUENCY FATIGUE AND VOLUNTARY CONTRACTILE PERFORMANCE DURING FATIGUING EXERCISE

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**Introduction** Dietary nitrate supplementation has been shown to increase skeletal-muscle force at low (<20 Hz) stimulation frequencies (Haider & Folland, 2014), which may be due to improved excitation-contraction (EC) coupling (Hernández et al., 2012). Disruption to EC coupling is thought to be a major contributing factor to reduced maximal voluntary force (MVF) during fatiguing exercise (Westerblad et al., 2000) and appears to have its greatest effect at low stimulation frequencies (low frequency fatigue; LFF). Thus, dietary nitrate supplementation may protect against LFF, and attenuate reductions in MVF during fatiguing exercise. The purpose of this study is to investigate the effects of dietary nitrate supplementation on voluntary performance and LFF during a fatiguing exercise. **Methods** 6 males visited the lab for a familiarisation, and 3 measurement trials. Trials 1 (baseline) and 2, and 2 and 3 were separated by 7 and 9 days respectively. In the 7 days before trials 2 and 3, participants consumed 2x70-ml shots per day of either nitrate-rich (0.4g/70ml) or nitrate-depleted (placebo) beetroot juice in a double blinded, counterbalanced order. In each trial participants completed a series of involuntary and voluntary isometric knee extensions at a 120° knee angle. Involuntary contractions involved 1-s tetanic contractions at 10, 20, 50, and 100 Hz at a stimulation current eliciting 50% of MVF at 100 Hz. Tetanic contractions were performed before and immediately after 60, 3-s maximal voluntary contractions (MVCs) separated by 2 s. Dependent variables included: the %Δ in peak tetanic force at each stimulation frequency from pre to post 60 MVCs; the %Δ in 20:50 Hz peak tetanic force from pre to post 60 MVCs; MVF; total impulse during the 60 MVCs, end-test force (average force of the last 6 MVCs); and fatigue index (%Δ in mean force from the first 6 to the last 6 MVCs). **Main effects of condition** (baseline, placebo, and nitrate) were determined with a one-way ANOVA. Results There was no main effect ( $P > 0.05$ ) of condition on MVF ( $677 \pm 168$  N); total impulse ( $63591 \pm 9187$  Ns); end-test force ( $229 \pm 41$  N); or fatigue index ( $56 \pm 7\%$ ) during the 60 MVCs. There was a similar decline in peak tetanic force at 10 ( $-57 \pm 11\%$ ), 20 ( $-51 \pm 14\%$ ), 50 ( $-38 \pm 14\%$ ), and 100 Hz ( $-38 \pm 14\%$ ) from pre to post 60 MVCs in all conditions ( $P > 0.05$ ). There was also a similar decrease in 20:50 Hz peak force from pre to post 60 MVCs in all conditions ( $-21 \pm 12\%$ ;  $P > 0.05$ ). **Discussion** Nitrate supplementation did not affect either voluntary contractile performance during the 60 MVCs, or LFF following the MVCs. Changes in EC coupling with nitrate supplementation may only occur in Type II muscle fibres (Hernández et al., 2012) and may have minimal influence on in-vivo whole muscle performance. References Haider & Folland (2014) *Med Sci Sports Exerc* 46: 2234-43 Hernández et al. (2012) *J Physiol* 590:3575-83 Westerblad et al. (2000) *Eur J Appl Physiol* 82:166-74

## IMPACT OF SELECTIVE PRE-FATIGUE ON QUADRICEPS SYNERGISTS ACTIVATION STRATEGY

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1: INSERM U1093, University of Burgundy (Dijon, France), 2: Institute of Sport Sciences, University of Lausanne (Lausanne, Switzerland) **Introduction** It is known that the activation strategy differs among the knee extensors, i.e. vastii vs. rectus femoris (RF), during a submaximal isometric contraction (I). This has been mainly attributed to functional anatomical differences between mono- and bi-articular muscles. The present study aimed to examine whether the activation strategy among the knee extensors was different when vastus lateralis (VL) was pre-fatigued. To do so, we compared the activation strategy, i.e. electromyographic (EMG) activity among knee extensor muscles during a sustained isometric submaximal contraction maintained until failure with or without pre-fatigue of VL. **Methods** Thirteen males participated in two experimental sessions (randomly assigned), consisting of maintaining 20% of maximal voluntary contraction torque (MVC) until task failure. For one of the session, the task was preceded (pre-fatigue) by 30 repeated submaximal fatiguing contractions of the VL muscle induced by electrical stimulation (ES; duty cycle 6.25s on - 27s off) at an intensity evoking 20% MVC. EMG activity of VL, vastus medialis (VM) and RF muscles and torque were continuously recorded. **Results** Time to task failure was significantly shorter with than without pre-fatigue ( $-23.2\%$ ,  $P < 0.001$ ). At the beginning of the contraction (first 10% of time to task failure), EMG activity did not differ between muscles with and without pre-fatigue, excepted for VM with pre-fatigue which was significantly higher (15.5, 16.3 and 16.0% MVC EMG vs. 15.5, 21.1 and 17.5% MVC EMG for VL, VM, RF muscles without vs. with pre-fatigue, respectively). For the last 10% of time to task failure, level of EMG activity of RF muscle was higher than VL and VM without pre-fatigue, whereas VM and RF were higher than VL with pre-fatigue (31.9, 33.5 and 37.5% MVC EMG vs. 31.9, 46.6 and 45.1% MVC EMG for VL, VM, RF muscles without vs. with pre-fatigue, respectively). **Discussion** We observed a different strategy among knee extensor muscle when VL was pre-fatigued. Interestingly, our results contrast with those from previous study (2) in which load sharing was not redistributed among the quadriceps muscles after selective pre fatigue of the VL muscle. These findings suggest that activation strategy of VM depends on the fatigue status of VL. **References** 1. Place N, Matkowski B, Martin A, Lepers R. (2006). *Exp Brain Res*, 174, 595-603. 2. Bouillard K, Jubeau M, Nordez A, Hug F. (2014). *J Neurophysiol*, 111, 768-776. Contact boris.matkowski@u-bourgogne.fr

## CONTRIBUTION OF THE ANKLE PLANTAR FLEXORS TO POWER PRODUCTION DURING SPRINT CYCLING

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**Introduction** Ankle plantar flexor muscles (APFs) impact human performance during exercises such as speed skating or vertical jumping (1). During cycling, APFs transmit the power generated by knee and hip extensors to the crank (2). Interestingly, large reductions of the net ankle joint power produced by the APFs accompany reductions in crank power during sprint cycling (3). The aim of this study was to investigate the effect of a force-loss of the APFs on the ankle joint power and crank power production during sprint cycling. **Methods** Ten participants performed a 30-s maximal cycling exercise under two randomized conditions: 1) control condition (CTL) and 2) after pre-fatiguing the APF muscles (APF-). In the APF condition, a 40% reduction in APF force (isoFAPF) was induced using a series of 3-s maximal isometric contractions interspersed with 6s recovery. Pre and post cycling sprints, neuromuscular testing (NMT) was completed to measure isoFAPF, isoEMG (SOL/GAS) and resting maximal M-waves (MSOL/GAS). EMG of APFs (cycEMGSOL/GAS), ankle joint power produced by APFs (cycPAPF) and crank power (cycPcrank) were calculated for the first and last 6s of the cycling sprints. Two-way ANOVAs with repeated measures (condition\*time) were used to analyse changes in the variables extracted. **Results** Reductions in isoFAPF ( $-39 \pm 10\%$ ), isoEMGSOL ( $-46 \pm 14\%$ ), isoEMGGAS ( $-40 \pm 16\%$ ), MSOL ( $-19 \pm 15\%$ ) and MGAS ( $-12 \pm 15\%$ ) were induced prior to the cycling exercise in the APF-condition. During the last 6s of the cycling sprints, cycEMGSOL ( $29 \pm 7\%$  vs.  $16 \pm 5\%$ ), cycEMGGAS ( $37 \pm 9\%$  vs.  $28 \pm 8\%$ ), cycPAPF ( $128 \pm 49$  W vs.  $37 \pm 14$  W) and cycPcrank ( $467 \pm 132$  W vs.  $231 \pm 52$  W) were all decreased ( $p < 0.05$ ). A larger condition effect was observed during the first 6s of the sprint for cycEMGSOL ( $-9 \pm 5\%$  vs.  $-3 \pm 2\%$ ), cycEMGGAS ( $-9 \pm 7\%$  vs.  $-5 \pm 6\%$ ), cycPAPF ( $-14 \pm 20$  W vs.  $-2 \pm 8$  W) and cycPcrank ( $-29 \pm 28$  W vs.  $-14 \pm 20$  W).



vs.  $-3\pm 36W$ ). Post sprint, isoFAPF ( $-13\pm 8\%$ ), isoEMGSOL ( $-34\pm 16\%$ ), isoEMGGAS ( $-14\pm 18\%$ ) and MSOL ( $-9\pm 17\%$ ) were lower during the APF-condition. Discussion Only small reductions in both the ankle joint power produced by the APFs and the power transmitted to the crank were observed following a large force-loss in the APFs, indicating that the impact of APFs on sprint cycling performance is lower than what is observed during vertical jumping and skating. Altogether our results also show that completion of a 30-s cycling sprint does not seem to induce fatigue in the APFs, suggesting that only low levels of force need to be produced by the APFs to allow the transfer of knee and hip extensor power to the crank. References 1. Van Ingen Shenau GJ (1989). Human Movement Science, 8, 301-337 2. Zajac, FE, Neptune RR, Kautz SA (2002). Gait & Posture, 16, 215-232 3. Martin JC, Brown NAT (2009). J Biomech, 42, 474-479 Contact david.rouffet@vu.edu.au

## Mini-Orals

### MO-SH10 Sports statistics & Analysis I

#### THE AGE-PERFORMANCE RELATIONSHIP: TOWARD NEW MODELS

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The physiological traits characterizing human capacities (the ability to move, reproduce or perform tasks) change with age: performance is limited at birth, increases to a maximum, then decrease back to zero at death. Both physical and intellectual skills follow similar ontogenies [1-3]. The development of sport and chess performances during the lifetime was previously investigated at two different scales: the individual athletes' careers and the world record by age class in 25 Olympic sports and in elite chess players [3]. For all data sets, a biphasic pattern of growth and decline is described by a simple equation [1] and the two processes (growth and decline) are exponential and operate throughout the lifetime, starting at age 0. PURPOSE: Here we aim to (i) demonstrate that this biphasic behaviour is probably widespread among biological phenomena (ii) introduce a new model to estimate the characteristics of the biphasic pattern (peak value, age of death). METHODS: Performances data were gathered for human (200, 400 and 800m races,  $n=5,065$ ,  $5,013$  and  $5,080$ , respectively), greyhound (480m competitions,  $n=47,991$ ), mice (distance run on wheels during 24h,  $n=14,241$ ) [4] and *Caenorhabditis elegans* (using an experimental eletrotaxis device). Two models were adjusted to the data: the equation of Moore [1], and a new model based on a populational approach. RESULTS: A U-inversed biphasic pattern is found in both the athletic (human Olympians and elite greyhound) and non-athletic (mice, *Caenorhabditis elegans*) species. The new model describes the dynamics of performance with aging with greater accuracy compared with the initial model, based on classical goodness-of-fit indicators ( $R^2$ , rmse, AIC, BIC). CONCLUSION: The pattern is robust, whatever the type of effort and duration: free activity vs. constrained running or overall distance traveled vs. maximum speed. Our results suggest a similar age-related pattern in very different species. The description of the physiological limits shows that there is no brutal transition between the developmental and senescent periods. It thus questions the narrowed link between those two processes. 1. Moore II, D.H. A study of age group track and field records to relate age and running speed. Nature 253:264-265 (1975). 2. Roring, R.W., Charness, N. A multilevel model analysis of expertise in chess across the life span. Psychology and Aging 22:291-299 (2007). 3. Berthelot, G., Len, S., Hellard, P., Tafflet, M., Guillaume, M., et al. Exponential growth combined with exponential decline explains lifetime performance evolution in individual and human species. Age (Dodr) 34:1001-1009 (2012). 4. Morgan, T.J., Garland, T., Carter, P.A. Ontogenies in mice selected for high voluntary wheel-running activity. I. Mean ontogenies. Evolution 57:646-657.

#### THE HERITABILITY OF AN OLYMPIC MEDAL: A POPULATION-BASED STUDY ON OLYMPIANS FROM THE GAMES OF 1896 UP TO 2012

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Background: Genetic and environmental factors have proved influence in sport performance. We hypothesize an inheritance component affecting the genetic and environmental interplay and thus, having a kinship with a former Olympic medalist may increase the chances of an athlete, to repeat the achievement of his/her kinship. We aimed to measure the heritability of an Olympic medal among Olympians. Methods: Cross-sectional study based on the entire population of athletes participating in the Olympics from 1896 up to 2012. Data concerning Olympics participation, medals obtained, biographies and kinship with other Olympians was collected for all Olympians ( $n = 125,051$ ). The frequencies of medals among Olympians presenting a kinship with a former Olympic medalist ( $n=1,086$ ) were compared to the frequency of Olympians presenting a kinship with Olympians non-medalist ( $n=4,575$ ) and with Olympians without a kinship in the games ( $n=119,390$ ). The pairs of studied kinships were: grandparents-granddaughter/grandson, aunt/uncle-niece/nephew, parents-offspring, siblings, dizygotic (DZ) and monozygotic (MZ) twins. The Qui-squared test was used to test whether the performance level is independent of a kinship with an Olympic medalist at 0.05 significance level. Concordance rates among twins were assessed by probandwise concordance rates, and the heritability ( $h^2$ ) variation of the phenotype genetically determined was estimated according to classical twins' studies. Results: The probability to obtain a medal related with the medals distribution in the games is 20.85%. Among Olympians with no kinship with other Olympians is 20.37% (95% CI: 20.1-20.6) and is not significantly different from Olympians with a non-medalist kinship ( $p>0.05$ ). Among Olympians presenting a kinship with a former Olympic medalist the probability to be also a medalist is: among granddaughter/son 36.84% (95% CI: 20.2-59.4,  $p > 0.05$ ); niece/nephews 44.44% (95% CI: 33.7-54.2;  $p < 0.001$ ), offspring 43.38% (95% CI: 37.4-48.6;  $p < 0.001$ ), siblings 64.8% (95% CI: 61.2-68.8;  $p < 0.001$ ); DZ twins 75.47% (95% CI: 63.3 - 86.6;  $p < 0.001$ ); MZ twins 85.71% (95% CI: 63.6 - 96.9;  $p < 0.001$ ); with significantly greater concordance between MZ than DZ ( $p = 0.01$ ) and  $h^2$  estimated at 20.48%. Conclusion: This study shows that high performance in sports is a heritable trait related with a genetic and environmental predisposition. Having a kinship with a previous Olympic medalist increases the probability of an Olympian to be also a medalist as greater is the coefficient of relatedness relying them.

## IT IS YOUR TEAMMATES NOT YOUR SCHOOLMATES THAT MATTERS: THE IMPORTANCE OF RISK POPULATION IN TALENT DEVELOPMENT STUDIES.

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Objectives: Studies have shown that elite athletes tend to come primarily from communities with a certain population size or density depending on the sport and nation (Côté et al. 2006; Bruner et al., 2011) this being commonly referred to as the birthplace effect. Birthplace studies have traditionally compared the distribution of elite players to census statistics across community categories, the census data representing the risk population from which talents originate. Recently, it was suggested that youth players should be a more appropriate risk population also to elucidate if elite players simply come from communities with more youth players (Rossing et al., 2015). Our objective was to examine how selection of risk population affects the analysis of birthplace effect among Danish male national youth handball players (NP). Methods: The sample included 80 Danish NP ranging from below 18 years to below 21 years (U18-U21) national youth teams in 2014. Risk populations were either 35.948 registered male youth handball players or 249.289 6-12 years old children. Birthplace communities were divided into six sub-divisions by population density and odds ratio (OR) were calculated comparing the odds for being a NP with odds for being a child in each community or a registered youth player for a specific community sub-division. OR results were considered significant if 95% confidence intervals (CI) did not include 1. Results: Compared to distribution of children aged 6-12 years, NP were overrepresented in medium density communities ( $\geq 100$ -250 pop./square km) (OR(CI)) (1.68(1.04-2.73)) with no other significant results. Compared to registered youth players, NP were underrepresented in low density communities ( $\geq 50$ -100 pop./square km) (0.44(0.24-0.88)) with no other significant results. Conclusions: The choice of risk population significantly affected results of the odds ratio analysis. This indicates that the distribution of registered youth players indeed is related to the distribution of players selected for the Danish national youth teams in handball. Therefore, future studies should also include youth players as risk population. The results of this study also suggest that the structure of the talent development in the Danish handball federation seem to create good opportunities to both rural and urban talented players. Bruner MW, Macdonald DJ, Pickett W, Côté J. (2011). *J Sports Sci*, 29, 1337-1344 Côté J, Macdonald DJ, Baker J, Abernethy B. (2006). *J Sports Sci*, 24, 1065-1073. Rossing NN, Nielsen A, Elbe AM, Karbing DS. *E J Sports Sci*. In press.

## DIFFERENCES BETWEEN BALL POSSESSION ON WHEELCHAIR-ATHLETE ACTIVITIES IN RELATION TO FIELD POSITION IN WHEELCHAIR BASKETBALL

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Introduction In wheelchair basketball, athlete performance is determined by the individual capabilities of the athlete, interaction with the wheelchair in combination with the requirements of the game. There are three field positions (guard, forward and centre) and each position has specific requirements and therefore specific physical and wheelchair actions. Athletes require a wheelchair design that best meets the demands of a specific sports discipline (Vanlandewijck et al., 2001). A better understanding of wheelchair-athlete activities is required for optimization of the wheelchair. In order to find out or detect regularities and principles in the game of (wheelchair) basketball, it is necessary to investigate individual parts of game flow like ball possession (Perica et al., 2011). Therefore, the aim of this study is to determine whether differences between field positions in wheelchair-athlete activities are different between ball possession and no ball possession during wheelchair basketball matches. Methods Using video analysis, absolute and relative duration of wheelchair movements (forward, backward, rotate, standing still, brake and block) and athlete control options (0, 1 or 2 hands) were examined in 27 Dutch National players and 29 International players during entire matches. Data were analysed using repeated measures ANOVA (with/ without ball possession) with a between subjects factor (field position). Results During a game, on average 21% of the active time guard players (n=18) had ball possession, while forward players (n=24) and centre players (n=14) possessed the ball for 16 and 18%, respectively. For the activity driving forward there was a statistically interaction (p=.02). Guard players drove relatively 4% more forward with ball possession compared without ball (Total percentage (TP) driving forward: 46%) while in contrast, forward players drove 6% less forward (TP: 45%) and centre players drove 8% centre less forward (TP: 45%). Conclusion During ball possession, both guards, forwards and centers showed different wheelchair-athlete activities compared to no ball possession for the activity driving forward. These findings indicates that mobility performance can be enhanced by focusing on the specific requirements of the different field positions in wheelchair basketball, for instance by optimizing the wheelchair design and settings. References Perica et al.(2011). *Physical Culture*, 65(2), 51-77. Vanlandewijck et al.,(2001).*Sports Medicine*, 31(5), 339-367. a.m.h.dewitte@hhs.nl

## RELATIVE AGE EFFECT AND PERFORMANCE IN YOUNG EUROPEAN FEMALE BASKETBALL CHAMPIONSHIPS

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Introduction An overrepresentation of relatively older participants, known as the Relative Age Effect (RAE) has been widely studied (Musch & Grondin, 2001), particularly in high-level sports (Romann & Fuchslocher, 2013). However, few studies have investigated RAE in women's basketball (Delorme & Raspaud, 2009) and no one has focused on European Female Championships. Thus, our aim was to describe the possible presence of this effect in young female elite players and national teams of U16, U18 and U20 cohorts to ascertain the underlying causes of RAE in women's basketball. Methods We analysed the following data: date of birth, height, minutes played and performance parameters of 1102 young female basketball players who took part in the European U16, U18 and U20 Female Championships. In order to avoid the possible effect of played minutes in performance parameters, all the data were normalised per minute played. To determine the performance of the teams, we also collected the classification of each national team in the championship. Results We observed a skewed distribution of the birth dates in the youngest two cohorts, with more players being born in the first quarter of the year (36%). However, this bias disappeared in the U20 championships. In addition, significant correlations were observed between relative age and certain performance related parameters such as played minutes, assists, steals and scored points (p<0.05). It is also noteworthy that the correlations were not significant when data were normalized per played minutes. Relative age was not correlated to height of the players. Regarding the classification, there were significant correlations between the classification achieved in the U20 and the relative age (p<0.005), with the teams with relatively oldest players being the best classified. Discussion Our results demonstrated that RAE is relevant in high-level female youth basketball, although differences in birth distribution were not so skewed as in male players. There was an overrepresentation of players born in the first quarter of the year in U16 and U18 championships and in the best teams of U20 championships. Trainers, coaches and youth sport authorities should consider the present findings in order to avoid unequal selections at early

ages. References Delorme, N., & Raspud, M. (2009). The relative age effect in young french basketball players: A study on the whole population. *Scandinavian Journal of Medicine & Science in Sports*, 19, 235-242. Musch, J., & Grondin, S. (2001). Unequal competition as an impediment to personal development: A review of the relative age effect in sport. *Developmental Review*, 21, 147-167. Romann, M., & Fuchslocher, J. (2013). Influences of player nationality, playing position, and height on relative age effects at women's under-17 FIFA world cup. *Journal of Sports Sciences*, 31(1), 32-40.

### THE RELATIONSHIP BETWEEN MOTIVATION FOR PHYSICAL ACTIVITY AND LIFESTYLE IN 10- TO 12-YEAR-OLD CHILDREN IN SOUTH KOREA AND JAPAN

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Introduction Children in Asia have been becoming increasingly inactive in recent years (Muller et al., 2013), and low motivation for physical activity (MPA) has been identified as a factor in the decline in their physical fitness. The objective of this study was therefore to investigate and compare countries (Korea and Japan) in terms of the relationship between MPA and lifestyle in elementary school-aged children. Methods The study participants were 985 children aged 10-12 years. The participants completed a questionnaire consisting of 41-items relating to MPA (Inomata, 1997) and lifestyle. The questionnaire elicited data pertaining to the following: afterschool lessons, play and games, study and motivation for learning (ML), and level of achievement regarding movement skills. MPA was subjected to factor analysis using the principal factor method and Promax rotation. To investigate the relationship between MPA and lifestyle, a multiple regression analysis was applied with dummy variables, thus establishing each MPA factor score as a dependent variable. Results MPA was found to involve seven factors: Self-awareness (S), Affinity with the activity (AF), Desire for achievement (Ach), Consistency with personal values (V), Activeness (Act), Competitiveness (C), and Desire to avoid failure (F). In the multiple regression analysis, the variables of the holding game machine, time of study, and gender were excluded from all formulas. The largest coefficients for each formula were as follows: gymnastics skills (.391[S], .304[Act]), high ML based on self-determination (.321[AF], .396[Ach], .284[V]), and low ML (.246[C], .330[F]). The significant (5%) regression coefficients for country were as follows: -.200[S], -.093[Act], .097[V], .090[F]. Discussion The levels of achievement pertaining to movement skills were generally higher in this study, and MPAs were higher regardless of nationality. In addition, ML pertaining to self-determination was higher in this study, as were MPAs pertaining to self-determination. Regarding those factors underlying MPA, Japanese children showed higher V and F and lower S and Act than their South Korean counterparts. These differences may be attributed to cultural differences between the two countries (Hong et al., 2009; Jang & Berry, 2011; Mochizuki & Ishida, 2009). The results revealed differences and similarities in the relationship between MPA and lifestyle in both countries, and identified areas for effective intervention in terms of increasing physical activity in children. References Hong H. R. et al. (2009). *Int J Sports med.* 30(9), 677-83. Inomata H. (1997). *J health, physical education & recreation*, 47(2), 131-35. Jang M. & Berry D. (2011). *Clin Nurs Res.* 20(3), 276-91. Mochizuki & Ishida (2009). *J Yamanashi maternal health.* 8, 48-54. Muller A. M. et al. (2013). *Asia Pac J Public Health.* 25(3), 227-38. Contact: tikedda@fukuoka-pu.ac.jp

### "MAGNITUDE-BASED INFERENCE": A STATISTICAL REVIEW

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We consider "magnitude-based inference" and its interpretation by examining in detail its use in the problem of comparing two means. We extract from the spreadsheets which are provided to users of the analysis (<http://www.sportsci.org/>) a precise description of how it is implemented. We compare the implemented version of the method with general descriptions of it and interpret the method in familiar statistical terms. We show that "magnitude-based inference" is not a progressive improvement on modern statistics. The additional probabilities introduced are not directly related to the confidence interval but rather are interpretable as p-values for two different, non-standard tests (for different null hypotheses). We also discuss sample size calculations associated with "magnitude-based inference" and show that the substantial reduction in sample sizes claimed for the method (30% of the sample size obtained from standard frequentist calculations) is not justifiable so the sample size calculations should not be used. Rather than use "magnitude-based inference", a better solution, is to use either confidence intervals or a fully Bayesian analysis.

### STUDY OF THE PERFORMANCE EVALUATION OF MASS SPORTS PUBLIC INPUT ON STRUCTURAL EQUATION MODEL ANALYSIS - BASED ON THE INVESTIGATION OF 25 PROVINCES IN CHINA

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Introduction Though the 《The nationwide body-building plan》 was carried out for more than 20 years in China, there is a big gap between the need of the general public and the sports facilities, organization system, fitness guidance, constitution monitoring, etc. The performance evaluation (PE) of mass sports public input (MSPI) is important to improve the level of public sports performance and the efficiency of resource assignment. Methods Base on the literature research, Delphi method, factor analysis method and structural equation model, we built a model for the PE of MSPI. After normalization of the path coefficients of the model, we determined the coefficients of the weight (CW). The CW of the input, output, and effect to the PE of MSPI are 0.22137, 0.38550 and 0.39313, respectively. The CW of the input in mass sports and sports facilities are 0.38931 and 0.61069 respectively. The CW corresponding to mass sports activity sites, the population of daily exercise, sports clubs, and the population of social sports instructors per 10,000 people to the output are 0.29412, 0.26144, 0.27124 and 0.17320, respectively. The CW of the population of reaching the national physical standard and the quantified rate on the effect are 0.75701 and 0.24299, respectively. Results and Discussion Using the PE index system, we got the empirical analysis on the performance of the MSPI for 25 provinces in China. (1) The public input performance in 2008-2014 is extremely low in mass sports in China, only Jiangsu and Shandong provinces in good and fair level. With the growing of economy and society, the performance levels of MSPI tend to increase accordingly. (2) The difference in performance level is defined as the performance difference between different regions within the same time period. It is a measurement of performance disparities among different regions. The differences in performance indicator of Guizhou and Qinghai provinces are the biggest. And the performance difference degree of the MSPI is tending to expand further from 2008 to 2014. (3) The performance improvement indicator refers the speed and degree of performance improved at the same area in different times. In 2009-2014, 19 out of 25 provinces, the MSPI performance improved at different levels. (4) The coincident index is the ratio of performance improvement indicators and social economic development speed, which is used to analyze the

orientation relationship between the performance of public input improvement and the level of social economic development speed. There are 17 provinces in China showed a tendency of synchronous growth of the MSPI performance with the per capita GDP. The PE of the MSPI should focus on indicators of output and effect. This also enlighten us to improve the performance of MSPI, namely, to strengthen the construction of sports facilities, to cultivate social sports instructors, to encourage more people into physical activity, and elevate the physical health level of people.

**15:00 - 16:00**

## Mini-Orals

### MO-PM14 Health & Fitness: Children, Team Sports

#### ACCEPTABILITY AND FEASIBILITY OF AN INTERNET-BASED INTERVENTION TO INCREASE PHYSICAL ACTIVITY AMONG ADOLESCENTS

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**Introduction:** The fact that most adolescents do not achieve the age-specific physical activity (PA) recommendations points out the importance of target-group specific interventions promoting PA (Roski, 2009; WHO, 2010). Current research shows that internet-based interventions, offered in addition to standard face-to-face interventions, are a promising approach to reach adolescents. However it is completely unclear whether this approach is accepted and to what extent it is used (Price et al., 2015). The aim of the study is to evaluate the acceptability and feasibility of an internet-based intervention to increase PA at school. **Methods:** The present study included five classes of 9-11th graders randomly chosen of five schools (3 high schools, 1 comprehensive school and 1 vocational school). The total sample was 119 (mean age: 14.8; boys=40%). Participants received an 8-week face-to-face intervention combined with an internet-based intervention. Acceptance and feasibility were analyzed. Acceptance was measured by a questionnaire, assessing usability, understandability, perceived benefits and perceived costs of the internet intervention. Feasibility was measured by usage of the portal (utilization rate, number of logins, consulted resources). **Results:** Response rate of the acceptability questionnaire was 64% (n=76). 84% (n=64) reported that the internet program was well understandable; the usability was accepted by 65% (n=49). 102 pupils (86%) logged in at least one time. The registered adolescents accessed the platform, with a task-completion rate of 25%. Overall login duration at the weekend was two minutes less than during the week. High school pupils used the platform weekdays significantly more often than participants attending comprehensive school ( $p \leq 0.000$ ). There are no differences in usage regarding sex and age. **Discussion:** The results show that low threshold facilities such as internet-based interventions offered in schools are accepted and feasible in regard of health promotion of adolescents. However, it is necessary to consider which functionalities of the internet platform were most frequently used and might be supportive in promoting PA (Lau et al., 2011). Furthermore we need to explore reasons for non-participation and identify strategies to increase the involvement. **References:** Lau, P. W. C., Lau, E. Y., Wong, D. P., & Ransdell, L. (2011). *Journal of Medical Internet Research*, 13(3). Price, M., Yuen, E. K., Davidson, T. M., Hubel, G. & Ruggiero, K. J. (2015). *Psychological services*. Roski, R. (2009). Wiesbaden: VS Verlag für Sozialwissenschaften. World Health Organization. (2010). Geneva, Switzerland: World Health Organization. Contact: c.grieben@dshs-koeln.de

#### IS PHYSICAL ACTIVITY OF ADOLESCENTS AND THEIR BEST CLASSMATES ASSOCIATED? A PILOT STUDY IN LITHUANIAN, NORWEGIAN AND SWEDISH HIGH SCHOOLS

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**Introduction** Boys and girls of primary school, whose best friends are physically active, have higher level of physical activity (1). The aim of this study was to investigate whether these relationships persist in adolescence. **Methods** In total, one hundred and eighty three school-children of 16 – 18 years of age from one secondary school in Kaunas (Lithuania), one secondary school in Oslo (Norway), and one secondary school in Malmö (Sweden) took part in this pilot study: from Lithuania there were 64 students (28 boys), from Norway - 60 (32 boys), and 59 students were from Sweden (33 boys). To measure their total amount of physical activity (PA) (i.e. the energy expenditure in MET-minutes/week) during the past seven days, the short form of an International Physical Activity Questionnaire (IPAQ) was used (2). The level of vigorous (VPA), moderate (MPA) and low (walking) intensity physical activities as well as the total amount of PA (ToPA) of the respondents was determined using IPAQ scoring protocol guidelines (3). **Results** Comparing high school students' physical activity according to country and sex, Lithuanian adolescent girls expend more energy in ToPA than Norwegian and Swedish girls ( $p < 0.05$ ). When ToPA is stratified into activities of different intensity, Lithuanian girls expend significantly more energy in walking than girls from Norway and Sweden, and more energy in MPA than Norwegians. In VPA the energy expenditure of Norwegian boys and girls is lower than of Lithuanian and Swedish ( $p < 0.01$ ). Statistically significant, but negative relationship between high school students' and their best classmate's levels of physical activity was found only in Swedish boys ( $r = -0.41$ ;  $p < 0.05$ ). **Conclusions** We may conclude that in adolescence the boys and girls, whose best friends are physically active, does not necessarily have higher level of physical activity as it was found in primary school. Norwegian adolescents, both boys and girls, expend significantly less energy in physical activities than their counterparts from Lithuania and Sweden. **References** 1. Jago R, Macdonald-Wallis K, Thomson J, Page AS, Brockman R, Fox KR (2011) Better with a Buddy: Influence of Best Friends on Children's Physical Activity. *Med Sci Sports Exerc*, 43(2), 259-65. 2. International Physical Activity Questionnaire. [http://www.ipaq.ki.se/downloads.html]. 3. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ), 2005 [http://www.ipaq.ki.se/scoring.pdf]. Contact vitakarvelyte@gmail.com

## EFFECT OF THE ROTATIONAL SPEED OF THE ROPE IN A PERSON TURNING A LONG JUMP ROPE IS ON THE HEART RATE AND OXYGEN UPTAKE

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1 Graduate school, kawasaki university of medical welfare, 2 Kawasaki university of medical welfare, 3 Kibi international university

**Purpose:** Exercising with a long jump rope is standard in elementary school physical education classes in Japan. However, there is no report that investigates the physiological responses of a person turning the long jump rope during long jump rope exercise. The purpose of this study was to clarify the effect of heart rate and oxygen uptake on a person turning a long jump rope at different rotational speeds. **Methods:** Subjects were six healthy Japanese males volunteered to participate in this study. Their age, height and body weight were  $22 \pm 1$  years,  $171.7 \pm 9.3$  cm and  $65.8 \pm 6.4$  kg, respectively (mean  $\pm$  SD). All subjects signed informed consent forms prior to participation in this study. The measurement conditions were set for a jump rope at three rotational speed conditions: 70, 90 and 110 rpms. The experimental protocol called for sitting in a chair at rest for five minutes, three minutes of exercise, and five minutes in a chair resting as a recovery. The exercise chosen was to turn a jump rope for three minutes at the three conditions. A long jump rope certified by NARJ (length of rope: 10 m) was used. Measurement indexes were heart rate, oxygen uptake, blood pressure and Rating of Perceived Exertion (RPE). **Results:** 90 and 110 rpm conditions showed significant heart rate increases one minute after the three minute exercise compared with the 70 rpm condition ( $p < 0.05$ ). 110 rpm condition showed significant heart rate increases one minute after the three minute exercise condition compared with the 90 rpm condition ( $p < 0.05$ ). 90 and 110 rpm conditions showed significant oxygen uptake increases one minute after the three minute exercise compared with the 70 rpm condition ( $p < 0.05$ ). 110 rpm condition showed significant oxygen uptake increases one minute after the three minute exercise condition compared with the 90 rpm condition ( $p < 0.05$ ). 90 and 110 rpm conditions showed significant increases in RPE one minute after the three minute exercise compared with the 70 rpm condition ( $p < 0.05$ ). 110 rpm condition showed significant increases in RPE one minute after the 3 minute exercise condition compared with the 90 rpm condition ( $p < 0.05$ ). **Discussion:** Changes in heart rate and oxygen uptake by using a hand ergometer are dependent on the rotational speed. In this study, when the rotational speed of the rope went up, heart rate and oxygen uptake increased exponentially. The exercise intensity of a person turning a long jump rope is limited by the speed of the rope's rotation. **Conclusion:** Changes in heart rate and oxygen uptake by a person turning a long jump rope were dependent on the rotational speed of the rope.

## RESIDENCE AND LIFESTYLE PARAMETERS IN YOUNGSTERS

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**Introduction** The modern life style and the achievements of the civilization mostly negatively effect the physical health, causing deviations of the posture and the skeleto-muscular system, especially because of the sedentary lifestyle or the low level of physical activity. In our present study the connection, if any, between the life style parameters and the dwelling circumstances, in respect of the size of the settlements was examined. **Methods** Among the higher classes of the elementary schoolchildren a questionnaire was used to gain information on their leisure time activity, on some basic nutritional aspects and about their own health status. Altogether 195 questionnaire (girls=100, boys=95) were analyzed in five different size of settlements, namely in a village (n=40), in a little town (n=40), in a larger town (n=40), in a county town (n=37) and in the capital (n=38). Within the settlements the type of the housing was asked and categorized as housing estate (blocks), family house, and new estate. The most important information on the leisure time activity structure and about the screen-time, and basic nutrients, meals and fast-food consumption were asked. Further information of any type of musculo-skeletal or postural deviation or deformity was gathered (e.g.: flat foot). BMI also was calculated by the self-reported body dimensions and were compared to the Hungarian reference values. For comparing the subgroups Student-t test for independent samples was used on the 0,05 level of significance. **Results** By our results we can state that by the size of the settlements the screen time was clearly increasing, especially in computer time, while it was more balanced in watching TV. For the latter the average time was about one or two hours equally, daily, for the whole sample. It is hard to tell if those having more time spent with computer have also the more time hanging on TV screen, or it is alternative. In the capital where more leisure time facilities could be easily reach, both the computer and TV screen time was less. Among other leisure time activities listening to music, sporting and family time was included in the first five order. Three-quarter of the whole sample evaluated their nutrition healthy, especially because of eating a lot of fruits and vegetables and less sweets. On the other hand somewhat less than half of the children eat fast foods. Children also were grouped by having flat foot or not. More of those with flat foot lived in block houses with less possibility of the open area and had extra weight. **Discussion** Both the extra weight and the dwelling, especially living in block housing estate develop flat foot. Lifestyle and dwelling have a definitive effect on the health status. In the larger settlements the rate of the overweight children was higher. More conscious and effective training could help to follow healthier lifestyle.

## ACADEMIC ACHIEVEMENT, OBESITY AND LOW FITNESS IN JAPANESE ADOLESCENTS

Morita, N.1, Nakajima, T.2, Okita, K.3, Fukuoka, R.4, Sagawa, M.1, Yamatsu, K.5

1. Hokkaido Univ. Education, Iwamizawa, Hokkaido; 2. Hokkaido Univ. Science, Hokkaido; 3. Hokusho Univ., Hokkaido; 4. Hokkaido Univ. Education; Saga Univ., Saga

**Introduction:** It has been shown that aerobic capacity is related to reading and arithmetic ability in children and that acute exercise enhances cognitive function (1,2). Also, childhood obesity has been reported to have a negative influence on cognitive function and academic achievement (3). However, there is no reports examined the influence of physical and physiological factors such as childhood obesity and low physical fitness on academic achievement in Japanese schoolchildren. The aim of this study was to investigate whether obesity and physical fitness are related to academic achievement in Japanese first-year junior high school students (equal to 7th graders in the U.S.). **Methods:** The data of 421 students (male, n = 222; female, n = 199; age = 12.4 yrs) were analyzed. Academic achievement was assessed by the total grade points of 8 school subjects (GP8; each subject was assigned 1 to 5 points) not including physical education. Comprehensive physical fitness was evaluated by the total score of 8 fitness tests including a 20-m shuttle run. Socioeconomic and behavioral confounders including mother's education, household income and cram school utilization were used as covariates. **Results:** The GP8 of students with a body mass index (BMI) over 25 was significantly lower than that of students with a BMI under 25 or under 18 (25.3 vs. 28.7 vs. 28.7 points, respectively;  $p < 0.05$ ). Comprehensive physical fitness and 20-m shuttle run test scores were correlated with GP8 in male students ( $r = 0.35$  and  $r = 0.36$ , respectively). In female students, only the 20-m shuttle run test score was correlated with GP8 ( $r = 0.16$ ). After adjusting for the confounders, comprehensive physical fitness score was found to be a significant factor for determi-

nants of GP8 in male students ( $\beta = 0.33$ ), but not in female students. Obesity status was a factor for GP8 in female students ( $\beta = -0.22$ ), but not in male students. Conclusion: These results suggest that obesity and low physical fitness could have a negative effect on academic achievement in Japanese junior high school students. References: 1. Kantomaa MT, Stamatakis E, Kankaanpää A, et al. *Proc Natl Acad Sci USA*. 2013; 110: 1917-22. 2. Syväoja HJ, Kantomaa MT, Ahonen T, Hakonen H, Kankaanpää A, Tammelin TH. *Med Sci Sports Exerc*. 2013; 45: 2098-104. 3. Kamijo K, Khan NA, Pontifex MB, et al. *Obesity*. 2012; 20: 2406-11. Contact: Email: morita.noriteru@i.hokkyodai.ac.jp

## ESTABLISHMENT OF MEASUREMENT SYSTEM REGARDING SIMILARITY OF MONOZYGOTIC AND DIZYGOTIC TWINS

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Introduction Scientific verification is impossible without quantitative assessment of the similarity or dissimilarity to the curve of growth pattern of twins. In this study, this assessment was verified by applying a cross-correlation function in analyzing changes from collapsing one of the curves to examine their similarity. The minimum growth curve must be functionalized to apply a cross correlation function. Thus it is important to approximate the growth curve by the Wavelet Interpolation Method proposed by Fujii (1999). Cross correlation function can then be applied to the quantified curve by Wavelet Interpolation Method. Methods : Longitudinal growth data consisting of height, weight, sitting height, and leg length was obtained for a pair of identical and a pair of fraternal twins from age six (first year of elementary school) to age 17 (third year of high school). : A cross correlation function is used to show the similarity between two waveforms, and the cross correlation function may be evaluated by convolving one function. In this study, a cross correlation function was assumed from the velocity curve values found from differentiation using the WIM for twins' physiques. < Analytical procedure>: WIM (Wavelet Interpolation Method) was applied to longitudinal growth data consisting of height, weight, sitting height, and leg length for pairs of identical twins and pairs of fraternal twins from age six (first year of elementary school) to age 17 (third year of high school). A cross correlation function was applied to the measured developmental indicators found by WIM and the velocity curve values. Results Changes in the cross-correlation coefficient found by applying the cross-correlation function to identical and fraternal twin height growth described by WIM and collapsing one (set of) growth distance values and velocity values. With  $r = 0.9$  for identical twins and  $r = 0.8$  for fraternal twins, similarity in identical twins was found to be very high when examining changes in correlation coefficients. Similarity among identical twins was also found to be high when weight, sitting height and leg length were analyzed, with high correlation coefficients in all three. Discussion Although it is only natural for identical twins to have a high degree of similarity, there is considerable variability amongst individuals making it possible for fraternal twins to have a high degree of similarity as well. Therefore identical twins showed clearly high cross correlation function in height growth. It is noteworthy that objective assessments can be made from the coefficient even when the difference in correlation coefficient is as slight as 0.1. Identical twins also showed a high degree of similarity in other physical attributes including weight, sitting height and leg length. References Fujii K, and Matsuura Y. (1999) Analysis of the growth velocity curve for height by the Wavelet Interpolation Method in children classified by maturity rate. *Am J Hum Biol*, 11, 13-30.

## Mini-Orals

### MO-PM16 Physiology: Strength

#### EFFECT OF AN INTENSIVE STRENGTH TRAINING MICROCYCLE ON RESTING HEART RATE VARIABILITY

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*Ruhr-University Bochum*

Introduction During the last decades, measures of heart rate variability (HRV) are receiving a growing interest for assessing cardiorespiratory fitness, as well as for monitoring fatigue and recovery in response to training stress. However, HRV-research has mainly focused on endurance training regimens and on team sports environments. Accordingly, evidence-based recommendations regarding the usefulness of HRV measures in an applied strength training setting are still missing. Therefore, the aim of the study was to investigate the influence of an intensive strength training microcycle (STM) on vagally-derived HRV indices, assessed under resting conditions. Methods Fifteen resistance-trained athletes (mean $\pm$ SD, female (n=7) 25.0 $\pm$ 1.5 yrs, 167.0 $\pm$ 4.9 cm, 62.0 $\pm$ 7.0 kg; male (n=8) 24.5 $\pm$ 2.1 yrs, 179.3 $\pm$ 6.3 cm, 76.5 $\pm$ 7.4 kg) completed a 6-day STM (eleven training sessions total) consisting of high-resistance (i.e., 85% 1RM) combined with maximal eccentric (i.e., 100% 1RM) strength exercises, both for upper and lower limbs. HRV (i.e., the natural logarithm of the square root of the mean sum of the squared differences between adjacent R-R intervals, Ln rMSSD) was assessed daily upon awakening in the morning (seven minutes under supine conditions) during a 4-day baseline period, a 6-day overload STM and a 4-day recovery period. HRV was analyzed using a 4-day rolling average. The smallest worthwhile change, calculated as one-half of the coefficient of variation, was used to determine practical significance through magnitude-based inferences (chances that the true difference was higher/trivial/lower) between baseline (Pre) and recovery (Post 1, Post 2, one and four days following STM, respectively). Results Ln rMSSD displayed a continuous negative trend during STM and was most likely decreased between Pre and Post 1 (0%/1%/99%). Changes between Post 1 and Post 2 were possibly positive (65%/35%/0%) but remained likely decreased between Pre and Post 2 (0%/6%/94%). Discussion The decrements in Ln rMSSD during STM suggest alterations in cardiac autonomic balance, which were commonly associated with fatigue and may possibly detect functional overreaching in endurance athletes. The changes after the STM indicate a state of fatigue at Post 1 and a not completely recovered state at Post 2. Although, current opinions on the usefulness of HRV assessments mainly focus on endurance-based training regimens, we provided data that HRV measures may further be of high value in monitoring fatigue and recovery in strength training-induced stress. References Buchheit M (2014). *Front Physiol*, 5(73). Hopkins WG (2007). *Sports Science*, 11, 16-20. Le Meur Y et al. (2013). *Med Sci Sports Exerc*, 45(11), 2061-2071. Contact christoph.schneider-a5c@rub.de

## THE EFFECT OF FUNCTIONAL OVERREACHING ON HEART RATE VARIABILITY AND PERCEPTIONS OF TRAINING TOLERANCE

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**Introduction:** Research suggests that weekly averages of daily heart rate variability (HRV) assessment may better predict overreaching than isolated daily measures (1,2). However, HRV has been shown to both increase and decrease in response to overreaching. This study aimed to determine whether combining assessments of training tolerance with weekly average values of resting HRV could indicate a state of functional overreaching. **Methods:** Vagal-related indices of HRV (Ln RMSSD and Ln SD1) and RR interval were recorded daily in supine (2 min) and standing (2 min) postures during 1 week of light-training (LT), 2 weeks of heavy-training (HT) and 10 days of tapering (T) in male runners/triathletes (n=15, age=35.1 ± 7.0 years, body mass=76.5 ± 8.6 kg, mean 5 km time-trial time=19:06 ± 2:10 min). RR interval, Ln RMSSD and Ln SD1 were analysed as weekly average values and as isolated values at the end of LT, HT and T. Measures of training tolerance (Daily Analysis of Life Demands for Athletes questionnaire, and perception of energy levels, fatigue and muscle soreness) were also recorded daily and analysed as weekly average values. Performance was assessed following LT, HT and T with a 5 km time-trial on a treadmill. **Results:** Time to complete 5 km increased by 21.8 ± 19.0 sec (P=0.002) following HT, and then decreased by 45.3 ± 27.4 sec (P≤0.001) following T, for an overall decrease of 23.5 ± 18.9 sec (P=0.001). Weekly average RR interval, Ln RMSSD and Ln SD1 in the standing position increased after HT in comparison to LT (P≤0.007), and remained higher than LT at T (P≤0.04), however isolated values remained unchanged. Weekly average and isolated values of RR interval, Ln RMSSD and Ln SD1 remained unchanged in the supine position. Training tolerance decreased after HT (P≤0.002) and then increased after T (P≤0.007). **Conclusion:** Vagal-related HRV indices in the standing posture increased after both HT and T in comparison to LT, demonstrating an increase in vagal modulation during both negative and positive adaptations to training. Thus, interpretation of HRV to diagnose such training adaptations is difficult in isolation, indicating the importance of measures of training tolerance to contextualise changes in HRV and allow for effective monitoring in the field. Supine measures of Ln RMSSD and Ln SD1, in addition to isolated values in both postures were not sensitive for detecting negative and positive adaptations to training. 1. Plews, DJ et al. *Int. J. Sports Physiol. Perform.* 2013; 8: 688-691. 2. Le Meur, Y et al. *Med Sci Sports Exerc.* 2013; 45: 2061-2071.

## INCREASED SATELLITE CELL PROLIFERATION WHEN CULTURED WITH POST-EXERCISE SERUM: ROLE OF TESTOSTERONE?

Luk, H.Y., Duplanty, A.A., Levitt, D.E., Budnar, R.G., McFarlin, B.K., Hill, D.W., Vingren, J.L.

University of North Texas

**Introduction** Testosterone (T) is a potent muscle growth facilitator, and long-term administration of T is positively associated with satellite cell activation and proliferation. Resistance exercise can induce a transient increase in a range of circulating biomarkers including T, but the effect of such transient increases on satellite cells (SCs) are not known. The purpose of this study was to examine the effect of the exercise-induced changes in circulating biomarkers on muscle SC proliferation. **Methods** Resistance trained young men (M; n=5; 26±3y) and women (W; n=7; 22±2y) participated in a heavy squat exercise protocol (6 sets of 10 repetitions at 80% of 1 repetition maximum). Serum was collected before exercise (PRE), and immediately (IP), 20, 40, 60, 120, and 180min after exercise and analyzed for T concentration. Muscle SC were loaded with proliferation dye and cultured with either PRE (CON) or the progression of PRE and the 6 post-exercise serums sample for 72h (EXE). SC were incubated with the 180min serum sample for the last 68.5h of the 72h incubation period. Then, SC proliferation was measured using image-based flow cytometry (Amnis FlowSight). **Results** Incubation with M's serum from EXE induced a significantly higher percent of SCs in generation (G) 5 [EXE: 17±4%; CON: 10±3%] and G6 [EXE: 3±1%; CON: 0±0%] compared to CON. Incubation with W's serum from EXE did not change proliferation compared to CON. For incubation with serum from EXE, M's samples resulted a significantly lower percentage of SCs in G1 (M: 4±4%; W: 16±3%) and G2 (M: 19±5%; W: 34±4.%) compared to W's samples, but a significantly higher percentage of SCs in G4 (M: 26±5%; W: 35±4%), G5 (M: 17±4%; W: 12±4%), and G6 (M: 3±1%; W: 0±0%). For incubation with serum from CON, M's samples resulted a significantly higher percentages of SCs (3-fold higher) in G4+G5+G6 compared to W's samples. Serum T increased significantly (p<0.05) from PRE (19±4 nmol·L<sup>-1</sup>) to IP (25±2nmol·L<sup>-1</sup>) and then gradually returned to PRE levels by 180 min (21±2 nmol·L<sup>-1</sup>) for M; no change in serum T was observed (PRE: 3±1; IP: 3±1; 180 min: 2±1 nmol·L<sup>-1</sup>) for W. Serum T concentrations were higher in M than in W at all-time points. **Discussion** When cultured with serum collected from M following heavy squat exercise SC grew at a faster rate compared to when SC were cultured with resting serum from M; this effect of exercise was not observed with serum from W. Furthermore, serum from M (CON or EXE) induced greater SC proliferation than serum from W. Given the observed gender differences in serum T at rest and in the response to exercise, and the physiological role of T, it is logical to speculate that these differences in T may underlie the observed differences in SC proliferation.

## HIGH-DOSE INHALED SALBUTAMOL DOES NOT INCREASE 10-KM TIME-TRIAL PERFORMANCE IN TRAINED CYCLISTS

Koch, S.1, Ahn, J.R.1,2, Koehle, M.S.1

1: UBC (Vancouver, Canada), 2: UWO (London, Canada)

**Introduction** Inhaled β<sub>2</sub>-agonists (IBAs) are used to prevent the transient narrowing of the airways during or following exercise, which is defined as exercise-induced bronchoconstriction (EIB). Athletes with EIB, who use IBAs tend to win a disproportionately greater percentage of the individual Olympic medals compared to athletes who do not use IBAs (Fitch, 2012). The aim of this study was to investigate if the maximum allowable daily dose of inhaled salbutamol (World Anti-Doping Agency, 2015), leads to an enhanced athletic performance in cyclists based on dose per kilogram of body weight (kg/BW). **Methods** Twenty trained, male cyclists performed two simulated 10-km time-trials on a cycle ergometer 30 min after the inhalation of either 1600µg salbutamol (APOTEX Inc., Toronto, Canada) or placebo using a crossover design. The Eucapnic Voluntary Hyperpnea (EVH) test (Anderson et al., 2001) was used to screen athletes for EIB. Eight athletes tested positive (EVH+) and 12 athletes tested negative (EVH-). Lung function, assessed by forced expiratory volume in 1 second (FEV1), was measured immediately before and 15min after drug treatment. Performance was measured by mean power output. **Results** Despite an increase in FEV1 (M(SD) = 6.4%(4.9%), p< 0.001) following salbutamol, mean power output remained unaffected, regardless of inhaled dose per kg/BW or EIB status. Mean heart rate (p = 0.01), respiratory rate (p = 0.01), minute ventilation (p = 0.03) and perceived leg fatigue (p = 0.03) were increased in the salbutamol time-trial compared to placebo. **Discussion** Even though the inhaled IBA-dose per kg/BW varied by up to 33% (17.8-23.71600µg per kg/BW), there was no ergogenic impact of supramaximal IBA treatment on a 15-minute task. The present study supports the findings by Dickinson et al. (2014) and Kalsen et al. (2014), showing no ergogenic effect of high-dose IBA

treatment on run and swim performances longer than 2min. Future research should focus on the ergogenic potential of high-dose IBAs in exercise protocols shorter than 2min at anaerobic intensities. One limitation of the study was the difficulty of blinding athletes due to the high prevalence of tachycardia and tremor. In an attempt to mitigate potential bias, the verbal encouragement during testing was standardized. . References Anderson SD, Argyros GJ, Magnussen H, Holzer K. (2001). *BJSM*, 35, 344-47. Dickinson J, Hu J, Chester N, Loosemore M, Whyte G. (2014). *J Sport Sci Med*, 13, 271-79. Fitch KD. (2012). *BJSM*, 46(6), 413-16. Kalsen A, Hostrup M, Bangsbo J, Backer V. (2014). *Scand J Med Sci Sports*, 24(5), 814-22. World Anti-Doping Agency (WADA). The World Anti-Doping Code. Accessed online Jan 7th, 2015: <https://wada-main-prod.s3.amazonaws.com/resources/files/wada-2015-prohibited-list-en.pdf> Contact sa-rahkoch@alumni.ubc.ca

### EFFECT OF ALTITUDE TRAINING ON MUCOSAL IMMUNITY AND SLEEP IN ELITE CROSS-COUNTRY SKIERS.

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**INTRODUCTION:** Altitude training is a key component of the training process of many of today's elite endurance athletes. However, evidence suggests that altitude training can compromise both cellular and mucosal immunity, as well as adversely affect sleep. The aim of the current study was to investigate changes in mucosal immunity and sleep in world-class endurance athletes during a training camp at moderate altitude. **METHODS:** Nine male (age  $23 \pm 3$  years,  $\dot{V}O_2\text{max}$   $81 \pm 4$  ml/kg/min) and two female (age  $23 \pm 1$  years,  $\dot{V}O_2\text{max}$   $67 \pm 2$  ml/kg/min) elite cross-country skiers volunteered written informed consent to take part in the study. Participants were all part of the Norwegian cross-country skiing team. Sleep was analysed via wristwatch actigraphy for five days at sea-level (SL) and for 10 days while living and training at 2000-3200 masl. Whole, unstimulated saliva samples were collected first thing in the morning at SL and on day 1, 3 and 10 at altitude for determination of salivary cortisol, testosterone and antimicrobial proteins (immunoglobulin-A, LL-37 and lysozyme) via ELISA. Saliva osmolality was determined by freezing point depression. Athletes logged details of every training session, both at sea-level and altitude, in a specifically designed on-line training diary. **RESULTS:** Total training volume increased by ~63% at altitude compared to SL ( $185 \pm 33$  min/day vs.  $113 \pm 20$  min/day,  $p < 0.05$ ). This was driven by an increase in low-intensity endurance training, while the volume of resistance exercise and high-intensity endurance training were significantly lower. Assumed sleep time was significantly reduced by ~11% at altitude compared to SL. Sleep efficiency was also reduced during nights 4-6 and 7-10 at altitude ( $79 \pm 5\%$  and  $81 \pm 5\%$  vs.  $85 \pm 7\%$  at SL,  $p < 0.05$ ). There were no changes in salivary cortisol and testosterone. However, when examined separately, male athletes had significantly reduced cortisol and increased testosterone:cortisol ratio on day 1 and 3 at altitude. Salivary immunoglobulin-A secretion was increased on day 3 at altitude ( $140$  [95% CI 73-230] vs. SL:  $75$  [95% CI 43-116]  $\mu\text{g}/\text{min}$ ,  $p = 0.013$ ), as was LL-37 secretion (day 3:  $6.0$  [95% CI 3.0-9.0],  $p = 0.044$ , and day 10:  $4.7$  [95% CI 2.5-6.8],  $p = 0.024$ , vs. SL:  $2.6$  [95% CI 1.6-3.6]). There were no significant changes in salivary flow rate, osmolality or lysozyme. **CONCLUSION:** With appropriately adjusted training and good nutrition, hydration and hygiene practices, it appears possible for athletes to live and train at moderate altitude without compromising immunity. On the other hand, both sleep quality and quantity are reduced. However, these reductions do not appear to be severe and could likely be compensated for by making provision for day-time naps and some modest adjustments in training and meal times to allow athletes more time in bed.

### EFFECTS OF REDUCED ARTERIAL CO<sub>2</sub> PRESSURE ON VENTILATORY AND CEREBROVASCULAR RESPONSES DURING PROLONGED EXERCISE IN THE HEAT

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**INTRODUCTION** Elevated body core temperature during exercise leads to increases in ventilation (VE) independently of metabolic factors, resulting in reduced arterial PCO<sub>2</sub> (hypocapnia) (Tsuji et al., 2012). Hyperthermia also decreases cerebral blood flow (CBF), which is one of the mechanisms behind decreased exercise performance in the heat. However, the effects of hypocapnia on VE and CBF during hyperthermic exercise are not fully understood. This study thus examined how temporary restoration of hypocapnia by inhaling CO<sub>2</sub> gas affects ventilatory and cerebrovascular responses during prolonged exercise in the heat. **METHODS** Eight healthy men performed a cycle exercise at 50% of peak oxygen uptake in the heat (38°C and 50% relative humidity) until esophageal temperature (Tes) reached 39°C. When during the exercise Tes increased by 1.0°C, 1.5°C and 2.0°C, and end-tidal PCO<sub>2</sub> (PETCO<sub>2</sub>, an index of arterial PCO<sub>2</sub>) decreased below 5-min level, subjects breathed CO<sub>2</sub>-enriched air (a mixture of room air and 100% CO<sub>2</sub>) for 2-3 min to restore reductions in PETCO<sub>2</sub> to the 5-min level. **RESULTS** VE increased with rising Tes from  $54 \pm 5$  l/min at 5 min (Tes of +0.4°C) to  $68 \pm 12$  l/min at Tes of +2.0°C ( $P < 0.01$ ), while PETCO<sub>2</sub> and middle cerebral artery blood flow velocity (MCAV) decreased from  $44 \pm 1$  mmHg and  $77 \pm 20$  cm/s to  $39 \pm 2$  mmHg and  $64 \pm 9$  cm/s, respectively (both  $P < 0.038$ ). CO<sub>2</sub> inhalation restored the decreased PETCO<sub>2</sub> to the 5-min level at any Tes level (+1.0, 1.5 and 2.0°C:  $43 \pm 1$ ,  $43 \pm 2$  and  $43 \pm 2$  mmHg, respectively, all  $P > 0.31$ ). This restoration of PETCO<sub>2</sub> significantly increased VE compared to pre-inhalation at any Tes level (+1.0, 1.5 and 2.0°C:  $60 \pm 6$  vs.  $65 \pm 7$ ,  $66 \pm 10$  vs.  $76 \pm 10$  and  $68 \pm 12$  vs.  $83 \pm 18$  l/min, respectively, all  $P < 0.018$ ). The PCO<sub>2</sub> restoration also significantly restored the reduced MCAV by 47-69% (+1.0, 1.5 and 2.0°C:  $71 \pm 15$  vs.  $74 \pm 16$ ,  $67 \pm 12$  vs.  $71 \pm 13$  and  $64 \pm 9$  vs.  $69 \pm 11$  cm/s, respectively, all  $P < 0.039$ ). **DISCUSSION** It is well recognized that in normothermic condition, hypocapnia suppresses VE via central chemoreceptors. The increases in VE caused by temporary restoration of hypocapnia in this study indicate that under hyperthermic conditions during exercise, hypocapnia suppresses VE. In addition, the ~50-70% increase in MCAV by the restoration of hypocapnia indicates that hypocapnia contributes largely to reductions in MCAV. Given our previous study in which during passive heating at rest, VE was unchanged and MCAV was restored by ~30-40% by temporary restoration of hypocapnia (Fujii et al., 2008), we speculate that hypocapnic effects on ventilatory and MCAV responses during hyperthermia differs between during exercise and at rest. In conclusion, present results suggest that during prolonged exercise in the heat, 1) ventilatory response with rising core temperature is suppressed by hypocapnia and 2) hypocapnia during hyperthermia largely accounts for reductions in CBF. **REFERENCES** Tsuji B, Honda Y, Fujii N, Kondo N, Nishiyasu T (2012). *J Appl Physiol* 113, 1388-1397. Fujii N, Honda Y, Hayashi K, Kondo N, Koga S, Nishiyasu T (2008). *Exp Physiol* 93: 994-1001.



### THE RELATIONSHIP BETWEEN MUSCLE THICKNESS AND MUSCLE VOLUME: MT IS A RELIABLE INDICATOR IN ASSESSING CHANGES IN SKELETAL MUSCLE MASS OF THE LOWER LIMBS IN RESPONSE TO RESISTANCE TRAINING

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The assessment of skeletal muscle mass is essential for quantifying hypertrophic responses to resistive training or in clinical scenarios, as in sarcopenia or disuse-atrophy (Heymsfield et al. 2014). In the last decades Computer Tomography (CT), Magnetic Resonance Imaging (MRI) and Dual-Energy X-Ray absorptiometry (DXA) have been used mainly in clinical settings to evaluate muscle mass; yet these techniques are expensive, not easily accessible and, in the case of CT, involve ionizing radiations. Recently, the use of ultrasound has been advocated as a potential reliable tool for assessing muscle architecture and ultimately mass/growth (Narici et al. 1999; Lieber et al. 2000; Sanada et al. 2006; Takai et al. 2014). Previous studies have shown that from a single scan, muscle thickness (MT) can be used as an indicator of increase in skeletal muscle size with hypertrophy (Akagi et al. 2008). Hence the purpose of the present study was to test whether MT could be used as a surrogate of muscle cross-sectional area (CSA) or volume in a population of healthy young males ( $n=8$ , age  $24\pm 1$  yr). The study received approval by the local Ethic Committee and informed consent was obtained from all participants. Muscle volume of the quadriceps femoris (QF) and vastus lateralis (VL) muscles was assessed by MRI (1.5 Tesla Philips AchievaScanner, NL) while MT of the VL muscle was measured by ultrasound (MyLab 70, Esaote Biomedica, It) at the distal 2/3 of femur length. Measurements were taken at baseline and at 28 and 84 days of a resistive exercise training (RET) programme (5 sets of 30 maximal isokinetic contractions at 90 deg/s performed 3 times/week). Correlation between the MRI and ultrasound measurements was tested by linear regression analysis. A significant correlation was found between VL VOL and VL MT ( $r=0.83$ ,  $P<0.001$ ) when all the values of Vol and VL MT were plotted independently from the time of acquisition; when instead the value at the 3 different time points were plotted separately, at Baseline, 28 and 84 days, the respective  $r$  values were  $r=0.88$ ,  $P<0.0001$ ;  $r=0.86$ ,  $P<0.0001$ ;  $r=0.83$ ,  $P<0.0001$ ). QF Vol vs. VL MT linear relationship was also significant ( $r=0.75$ ,  $P<0.001$ ), as was VL CSA vs. VL MT ( $r=0.80$ ,  $P<0.001$ ). The present data not only support the contention that MT may be regarded as a reliable index of skeletal muscle volume and CSA, but also that ultrasound could be a useful alternative to MRI for detecting changes in muscle mass with hypertrophic responses to RET. 1- Heymsfield SB et al. *J Cachexia Sarcopenia Muscle* 2014 2- Narici MV, *J Electromyogr Kinesiol* 1999 3- Lieber & Friden, *Muscle Nerve* 2000 4- Sanada et al. *Eur J Appl Phys* 2006 5- Takai et al. *J Nutr Health Ageing* 2014 6- Akagi et al. *J Strength Cond Res* 2008

### EFFECT OF A TAILORED, 12-WEEK, MODERATE-INTENSITY, STRENGTH TRAINING PROGRAM ON INDIVIDUALS WITH AMYOTROPHIC LATERAL SCLEROSIS

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Introduction Amyotrophic Lateral Sclerosis (ALS) is a fatal, rapidly-progressive, neurodegenerative disease of unknown origin, characterised by motor neuron degeneration and inexorable skeletal muscle weakness. The safe range for therapeutic exercise in individuals with ALS (iALS) has been narrowed, because of the variegated expression of the disease and the possible overuse effects on weak muscles. However, evidence supporting a beneficial role for moderate-intensity exercise in iALS is emerging (Dal Bello-Haas & Florence 2013), based on the assumption that exercise can minimise the superimposed disuse that inevitably accompanies the neurogenic atrophy caused by the disease itself. The objective of this study was to evaluate the effects of tailored, moderate-intensity, strength training on functional capacities and strength in iALS. Methods Seven iALS ( $50.9\pm 6.5$  yrs; mean $\pm$ SD; M/F: 5/2) undertook 12 weeks of resistance training at about 60% of their 1 Repetition Maximum (RM), 3 times a week. Each session started with 15 min of cycling at an intensity corresponding to 50% between baseline and the ventilatory threshold on a cyclo-ergometer. Exclusion criteria were ALSFRS  $<24$  or desaturation index  $<92\%$  during exercise. Before and at the end of the training we evaluated the 1RM for the leg extension (LE), arm curl and lateral raise exercises, and the exercise capacity (VO<sub>2</sub>peak) on a cyclo-ergometer. Participants also performed the "Timed Up and Go" test (TUG) and the "6 min walking test (6MWT)". Results Even if the post-training values were increased by 16% (VO<sub>2</sub>peak), 70% (arm curl) and 29% (arm lateral raise), these increases did not reach significance. The 1RM value for the LE also increased by 60.3% from  $39.8\pm 21.8$  to  $63.8\pm 42.9$  kg ( $p=0.07$ ). An improvement in the functional tests was noticed (9% increase in TUG and 2% increase in 6MWT), but without statistical difference. Conclusion This study showed that 12 weeks of tailored, moderate-intensity, strength training maintains strength and functional motor skills in iALS. In addition, these results indicate that exercise does not debilitate iALS. Indeed, interventions such as exercise, that maximize function, will become increasingly important in the disease treatment. Further studies with larger number of iALS are required to confirm our statements. References Dal Bello-Haas V & Florence JM. (2013). *The Cochrane Collaboration*. 1,34 Contact alesandra.ferri@unimib.it

### PCOS AND MUSCLE STRENGTH: PRELIMINARY RESULTS IN NORMAL WEIGHT WOMEN

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Polycystic ovary syndrome (PCOS) is a very common endocrinopathy in reproductive-aged women, characterized by hyperandrogenism, chronic anovulation and polycystic ovaries on ultrasound. PCOS is also frequently associated with body fat excess and insulin resistance, factors that may limit physical performance. However, androgen excess could be an advantage, in these women, in terms of increased muscle strength and performance. To date, only few studies in overweight/obese women have addressed the possibility that PCOS may be associated with changes in muscle strength, with controversial results. The aim of this study was to assess muscle strength in a sample of normal weight PCOS women (to avoid the confounder effect of excess body fat) compared with healthy controls. Eight women with PCOS and 10 age- and BMI-matched healthy controls, with a similar level of habitual physical activity, were recruited. The strength of the knee extensor muscle of the dominant leg was assessed by isokinetic dynamometry at two different rates of execution (30°/s and 120°/s) in concentric and eccentric phase, whereas muscle architectural characteristics (thickness, fascicle length and pennation angle) were analyzed by ultrasound scan of the vastus lateralis muscle. Anthropometric and metabolic features, serum total and free testosterone levels (as measured by LC-MS/MS and equilibrium dialysis) were also assessed. As expected, testosterone levels were higher in PCOS women compared with controls, while no significant differences were observed in body composition and metabolic features between PCOS and controls. The PCOS group showed greater isokinetic muscle strength in concentric phase at slow rate of execution (30°/s) (difference between groups 17%,  $p=0.04$ ), whereas borderline differences were observed at higher rates of execution. No differences in

muscle architectural characteristics were found. In conclusion, this preliminary study suggests that women with PCOS have increased muscle strength. Further research should assess whether this phenomenon may be related to the effects of hyperandrogenemia on muscle fiber expression.

## Mini-Orals

### MO-PM18 Physiology: Mixed session I

#### DIVING RESPONSE DURING DRY STATIC APNOEA: COMPARISON BETWEEN ELITE MALE AND FEMALE DIVERS

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Introduction Elite divers (ED) are able to maintain very long apnoeas through the diving response (DR), characterized by bradycardia, reduced cardiac output (CO), blood shift and increased mean blood pressure (MBP). This scenario has been well characterised and changes in heart rate (HR), stroke volume (SV), MBP and arterial oxygen saturation (SaO<sub>2</sub>) were described several times. However little attention has been put on the possible effect of gender on DR (Tocco et al., 2012; Cherouveim et al., 2013). We focused on the gender effect on hemodynamic changes during dry static apnoea. Methods 17 ED (9-M and 8-F) were tested in three conditions: A) 3 min resting with normal breathing, B) 140 s breath-hold in air and C) 1 min recovery. SV, HR, SV/ventricular ejection time ratio (SV/VET), SV/diastolic time ratio (SV/DT) and systemic vascular resistance (SVR) were assessed through impedance cardiography. A sphygmomanometer and a fingertip pulse oximeter were applied to detect MBP and SaO<sub>2</sub>. The mean value of each variable was calculated over 5 heart beats for every 20 s. To compare subjects with different gender, data were transformed into percentage changes from A. Results HR initially increased (+20%) and after started to decline until the end of apnoea (-20%), in both groups. SV firstly decreased (-30% in M and -50% in F) then returned to condition A. As consequence during the first 40 s of condition B a drop in CO, greater in F than M (-45% vs. -20%, p<0.05) took place. A similar time course was found for SV/VET (F -45% vs. M -24%, p<0.05). SV/DT values increased in M and decreased in F (+25% vs. -25%, p<0.05) and SVR rose with a marked gender effect (F +100% vs. M +30%, p<0.001). Finally, MBP raised until the 30% of A and SaO<sub>2</sub> dropped to 5% at the end of B condition in both groups. Conclusion Results show that overall the DR was similar in M and F but we first found that DR in F was more promptness in term of CO reduction and vasoconstriction response (i.e. SVR increase). We speculate that the elevation in intrathoracic pressure, which is observed when apnoea is sustained at large lung volumes (Ferretti, 2001; Novaliija et al., 2007) could be different between genders and it could be partially explain the present results. In our opinion the effect of gender on DR is little known and deserves further researches. References Ferretti G. (2001) *Eur J Appl Physiol*, 84,254-271 Novaliija J, Lindholm P, Loring SH, Diaz E, Fox JA, Ferrigno M. (2007). *Undersea Hyperb Med*, 34(6):415-422 Tocco F, Crisafulli A, Melis A, Porru C, Pittau G, Milia R, Concu A. (2012). *Eur J Appl Physiol*, 112,543-554 Cherouveim ED, Botonis PG, Koskolou MD, Geladas ND. (2013). *Eur J Appl Physiol*, 113,1321-1330 Contact:lsaretta84.m@gmail.com]

#### IMPORTANCE OF ANTHROPOMETRIC, HAEMODYNAMIC AND RESPIRATORY PARAMETERS TO DETERMINE PERFORMANCE DURING BREATH-HOLD DIVING

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Introduction Overall, elite divers' (ED) ability to sustain very long apnoeas depends on high pulmonary volumes and diving response (DR), which through cardiac output (CO) reduction and blood shift causes an oxygen sparing effect. We evaluated the correlation among several respiratory and hemodynamic parameters, measured during dry-apnoea performed in laboratory setting, and the performances reached during real breath-hold diving competition (AIDA World Team Championship 2014). Moreover, we sought for possible gender differences (Tocco et al., 2012; Cherouveim et al., 2013). Methods Breath-hold in air (BHA) was performed by 15 ED (7-M and 8-F). Before starting tests height and body mass were measured to determine the body surface area (BSA). Forced vital capacity (FVC) was assessed by the use of computer-based spirometer. CO was assessed by means of impedance cardiography and a standard sphygmomanometer was used to detect the blood pressure (BP). Thus, systemic vascular resistance (SVR) was obtained by dividing the mean BP (calculated as diastolic BP+1/3systolic BP-diastolic BP), by CO. Data were processed by non parametric statistics (Spearman test) to evaluate their correlation with the performances obtained in static (SA) and dynamic (DA) apnoeas and during constant weight diving (CWD). Results Significant correlation was found among BSA and the SA and DA performances ( $r_2=0.67$  and  $r_2=0.73$  respectively;  $p<0.05$ ) in males only. No correlation between CWD and any of the variables collected during BHA was demonstrated. Conclusion Results addressed to the hypothesis that divers' anthropometric characteristics more than promptness in term of CO reduction and vasoconstriction response were determinant in performing SA and DA. Besides, this was found in males only and confirmed previous remarks (Ferretti et al. 2012). The results of the present investigation suggest that our pre-competition evaluation tests were of limited use to predict racing outcome. References Ferretti G, Costa M, Moroni R, Ranieri P, Butti F, Sponiello N. (2012). *Sport Sci Health*, 7, 55-59. Tocco F, Crisafulli A, Melis A, Porru C, Pittau G, Milia R, Concu A. (2012). *Eur J Appl Physiol*, 112, 543-554 Cherouveim ED, Botonis PG, Koskolou MD, Geladas ND. (2013). *Eur J Appl Physiol*, 113,1321-1330 Contact:ffilippo.tocco@iscali.it]

#### THE EFFECTS OF HIGH INTENSITY PHYSICAL TRAINING ON ADIPOKINES OF MEN WITH METABOLIC SYNDROME

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Introduction Metabolic Syndrome (MS) is characterized as a grouping of metabolic risk factors and a pro-inflammatory status, related to central adiposity and insulin-resistance. The adipokines secreted by the adipose tissue have an important role in the metabolic and inflammatory complications associated to SM and obesity (Ouchi et al., 2011). It is already well known that physical exercise has an important influence on MS risk factors and inflammatory profile, especially aerobic exercises (Colombo et al., 2013). Therefore, the aim of this study was to analyze the effects of 15 weeks of anaerobic high-intensity physical exercise on adipokines of men with MS. Methods The sample included 21 men aged between 40 and 66 years, diagnosed with MS according to NCEP/ATP-III (2001) parameters. They had anthropometric measures and blood sample collected before and after 15 weeks of physical training, that consisted in a high intensity

physical exercise protocol, 3 times a week, lasting approximately 1 hour, where muscle resistance exercises were performed (60 to 80% of maximal load). The statistical analyses used Student t test and Wilcoxon Rank Test. Results A decrease in body fat percentage ( $32.51 \pm 5.02$  to  $31.90 \pm 5.15$ ,  $p < 0.05$ ) and an increase in body lean mass percentage ( $64.12 \pm 4.73$  to  $64.68 \pm 4.87$ ,  $p < 0.05$ ) were observed. The physical training also diminished resistin ( $77.8 \pm 5.56$  vs  $58.57 \pm 8.11$  ng/mL,  $p < 0.001$ ), ghrelin ( $49.47 \pm 5.7$  vs  $7.45 \pm 40.23$  pg/mL,  $p < 0.001$ ) and leptin ( $140.57 \pm 7.76$  vs  $83.9 \pm 10.94$  ng/mL,  $p < 0.001$ ) levels, and increased adiponectin levels ( $39.09 \pm 6.41$  vs  $79.14 \pm 12.98$  ng/mL,  $p < 0.001$ ). Discussion It was observed that the high intensity exercise protocol increased lean body mass and decreased body fat, which may have caused the positive changes viewed in the adipokines towards an anti-inflammatory effect, since the adipose tissue produces these proteins. There is growing evidence that exercise exerts its beneficial effects partly through alterations in the adipokine profile, that is, exercise increases secretion of anti-inflammatory adipokines and reduces proinflammatory cytokines (Golbidi; Laher, 2014). Thus, it was concluded that a high intensity exercise protocol causes decreases in the pro inflammatory metabolic proteins, leptine, ghrelin and resistin, and decreases the levels of the anti-atherogenic protein, adiponectin, therefore, is an excellent treatment and prevention for MS. References Colombo CM, de Macedo RM, Fernandes-Silva MM, Caporal AM, Stinghen AE, Costantini CR, Baena CP, Guarita-Souza LC, Faria-Neto JR. (2013). *Einstein* 11(3):324-30. Golbidi S, Laher I. (2014). *Journal of Diabetes Research* 1:1-14. NCEP/ATP-II. (2001). *JAMA* 285:2486-2497 Ouchi N, Parker JL, Lugus JJ, Walsh K. (2011). *Nat Rev Immunol* 11(2):85-97.

### A COMPARATIVE STUDY OF LOW VOLUME HIGH INTENSITY INTERVAL TRAINING VERSUS MODERATE INTENSITY CONTINUOUS TRAINING FOR A RECREATIONALLY ACTIVE POPULATION

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Introduction High intensity interval training (HIIT) protocols have been shown to be effective at inducing physiological remodeling similar to continuous moderate intensity training despite reduced time commitment and relatively small total exercise volume (Gibala et al. 2008). Critical velocity is defined as peak power output, measured in Watts, maintained over a 1-minute period. The aim of the current study was to assess the effectiveness of an exercise protocol prescribed using the critical velocity model of HIIT compared to moderate intensity continuous training (MICT) on a recreationally active population. Methods Sixteen recreationally active men ( $n=16$ , age =  $29 \pm 7$ ) were allocated to HIIT ( $n=8$ ) or MICT ( $n=8$ ) group and undertook testing pre- and post-intervention which included anthropometric and maximal oxygen uptake (graded exercise test GXT) measurements. Participants in both groups undertook 6 sessions over a 2-week period no less than 24 hours apart. The HIIT protocol consisted of 6 bouts of 20 seconds at 170% of participant's critical velocity (determined from GXT) interspersed with 100 seconds of low intensity exercise at 50 Watts. Warm up and cool down exercises gave a total time commitment of 18 minutes. Workloads elicited 80-100% of maximum heart rate (HRmax). The MICT protocol consisted of 50 minutes of 40% of participant's critical velocity (determined from GXT), workloads elicited 65-75% of HRmax. Data is communicated as mean  $\pm$  SD. A paired t-test and one-way Anova was performed to assess the relative effectiveness of the different exercise regimes. Results The results show no significant changes across anthropometric data in the HIIT group for weight ( $89.3 \pm 9.4$  vs.  $88.8 \pm 8.9$  kg), BMI ( $28.5 \pm 3.7$  vs.  $28.3 \pm 3.5$ ) or body fat percentage (BF%) ( $24.2 \pm 8.9$  vs.  $24.0 \pm 4.8\%$ ). The MICT group showed a statistically significant change in weight ( $81.9 \pm 6.1$  vs.  $80.9 \pm 6.1$  kg;  $p=0.001$ ) and BMI ( $26 \pm 2.3$  vs.  $25.6 \pm 2.4$ ;  $p=0.023$ ), no substantive difference in BF% ( $20.1 \pm 4.0$  vs.  $20.2 \pm 4.4\%$ ) pre and post-intervention were observed. Statistically significant improvements in the  $VO_{2peak}$  for both HIIT ( $39 \pm 5.5$  vs.  $43 \pm 7.5$  ml.kg<sup>-1</sup>.min<sup>-1</sup>;  $p=0.04$ ) and MICT ( $44 \pm 5.5$  vs.  $47 \pm 7.5$  ml.kg<sup>-1</sup>.min<sup>-1</sup>;  $p=0.024$ ) groups were observed. The time to exhaustion (TTE) of the HIIT group ( $28 \pm 3.7$  vs.  $30 \pm 3.1$  mins;  $p=0.05$ ) showed a statistically significant improvement unlike the MICT group ( $27 \pm 3.7$  vs.  $28 \pm 3.9$  mins) who displayed only a modest improvement within the error limit. Discussion These findings provide a comparative insight into the relative merits of HIIT and MICT exercise regimes on a recreationally active population. While the HIIT group showed no significant improvements in weight, BMI or body fat composition, the improvements in  $VO_{2peak}$  and TTE indicate that HIIT offers a effective alternative to MICT for improving cardiorespiratory fitness. The marked decrease in time required for HIIT suggest that it could provide a attractive alternative to MICT when time is a limiting factor to exercise. References Gibala MJ, (2008) *Exercise Sport Sci Rev*;36: 58-63 brianhughes123@hotmail.com

### PGC-1 $\alpha$ GENE EXPRESSION INDUCED BY INTERVAL EXERCISE AT LACTATE THRESHOLD

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Introduction Peroxisome proliferator-activated receptor gamma co-activator-1 alpha (PGC-1 $\alpha$ ) plays a key role as an activator of mitochondrial biogenesis. So, study of exercise protocol to induce the expression of PGC-1 $\alpha$  is important. Previous study demonstrated that PGC-1 $\alpha$  mRNA was increased by continuous exercise at intensity above the Lactate Threshold (Tobina et al., 2011). However little is known about the effect of interval exercise at lactate threshold intensity on PGC-1 $\alpha$  mRNA expression. Since lactate threshold intensity interval exercise is safe, practical and well tolerated by untrained individuals, it is important to determine whether lactate threshold intensity interval exercise induces PGC-1 $\alpha$  gene expression. Therefore, the purpose of this study is to examine whether lactate threshold intensity interval exercise induces PGC-1 $\alpha$  gene expression. Method Nine healthy subjects ( $28.6 \pm 14.1$  years,  $168.2 \pm 8.1$  cm,  $63.2 \pm 8.2$  kg,  $22.3 \pm 1.9$  kg m<sup>-2</sup>), Prior to this experiment, it was performed using a treadmill exercise test to determine the lactate threshold. They performed interval exercise at lactate threshold intensity. They repeated 40 jogging-walking sets on treadmill (jogging of 1min, and walking of 30sec). Muscle biopsy was taken from the vastus lateralis muscle under local anaesthesia before, and 3 hours after exercise. Blood lactate was measured before and after exercise. RPE was recorded every 10 sets were completed. Result PGC-1 $\alpha$  mRNA was increased 3 hours after exercise ( $2.78 \pm 1.80$  - fold,  $p < 0.05$ , respectively). Blood lactate was unchanged after exercise ( $1.2 \pm 0.5$  to  $1.3 \pm 0.5$ ,  $p = 0.09$ ). RPE was unchanged during exercise (10set :  $12 \pm 1$ , 20set :  $12 \pm 1$ , 30set :  $12 \pm 1$ , 40set :  $12 \pm 1$ ). These results indicate that PGC-1 $\alpha$  mRNA expression was induced by lactate threshold intensity interval exercise without elevation of blood lactate and RPE. Conclusions Lactate threshold intensity interval exercise can induce PGC-1 $\alpha$  mRNA expression. References: Tobina T, Yoshioka K, Hirata A, Mori S, Kiyonaga A, Tanaka H.(2011) *The Journal of Sports Medicine and Physical Fitness* The Journal of Sports Medicine and Physical Fitness, 4,683-688

## LARGER BETA SYNCHRONIZATION IN ELDERLY SUGGESTS BRAIN-RELATED ADAPTATIONS IN SELECTIVE INHIBITORY PROCESSES

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1: GRISSUL (Lausanne, Switzerland), 2: Institute of Neuroscience and Psychology (Glasgow, United-Kingdom), 3: INSERM (La Tronche, France), 4: Clinical Neurophysiology and Neuroimaging Unit (Geneva, Switzerland). Introduction Recently, we distinguished concomitant post-movement beta synchronization (PMBS) related to sensory reafference and active inhibitory processes (respectively over the left and right hemispheres) after a selective stop of the left hand in young adults (Sallard et al., 2014). In elderly, the modulations of PMBS in relation to these two processes have not been investigated yet. Here, we compare the spatio-temporal brain modulations in a selective motor inhibition task between old and young adults. Methods Seventeen young ( $25 \pm 3$  years) and 13 old ( $67 \pm 4$  years) adults participated to the study. For each trial, the participants started with a simultaneous bimanual (BM) index fingers' tapping (2 Hz). At a first visual signal, they had either to prepare to selectively stop the left index while continuing the tapping with the right index (SWIT condition), or to maintain the BM tapping. They executed the required action after the imperative auditory stimulus. A time-frequency analysis was performed on each trial (epoch of interest:  $-2500/+2500$  ms time-locked on the imperative stimulus). The PMBS measures were obtained by averaging the energy across the beta band (14-30 Hz). We focused on the SWIT condition and compare time-frequency signals between young and old groups. In addition, we estimated electric sources using a distributed linear inverse solution based on a local autoregressive average (LAURA) regularization approach. Results Behavioral results showed that old adults significantly increase inter-tap variability and error rates at the switching. The EEG analyses revealed larger PMBS amplitude in the old compared to the young group from 1400 to 2500 ms after the imperative stimulus onset. Source estimation analyses showed larger PMBS amplitude within the bilateral frontal and parietal cortices in old adults. Solution points with maximal differences localized these effects within the left superior parietal lobule, left superior frontal gyrus and left precuneus. Discussion Our findings show 1) that the old participants encounter difficulties in selectively stop one hand while stabilizing the tapping of the other and 2) a larger fronto-parietal network in the elderly to perform the selective inhibition task. The late occurrence of that additional recruitment of brain areas might help the elderly to actively maintain the inhibition of the left hand and to prevent its re-initiation. These brain-related adaptations are discussed in terms of dedifferentiation/compensation processes. References Sallard E, Tallet J, Thut G, Deiber M-P, Barral J (2014). Behav Brain Res, 271, 365-373 Contact jerome.barral@unil.ch

## BLUNTED ANGIOGENESIS AND HYPERTROPHY ARE ASSOCIATED WITH INCREASED FATIGUE RESISTANCE AND UNCHANGED AEROBIC CAPACITY IN OLD OVERLOADED MOUSE MUSCLE

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Background: The hypertrophic response in old mouse and human muscle is attenuated (Ballak et al., 2015; Slivka et al., 2008). We hypothesise that 1. this is partly due to a reduced capillarisation and angiogenesis, which is 2. accompanied with a reduced oxidative capacity and fatigue resistance in old control and overloaded muscles, that 3. can be rescued by the anti-inflammatory anti-oxidant resveratrol. Methods: To investigate this, the hypertrophic response, capillarisation, oxidative capacity and fatigue resistance of m. plantaris were compared in adult 9- and 25-month-old non-treated and 25-month-old resveratrol-treated mice. Results: Capillarisation was not significantly affected by age. Overload increased the local capillary to fibre ratio more in adult than old muscle ( $P < 0.05$ ), indicating attenuated angiogenesis in old muscles. Although muscles of old mice had a higher succinate dehydrogenase (SDH) activity ( $P < 0.05$ ) and a slower fibre type profile ( $P < 0.05$ ), the isometric fatigue resistance was similar in 9- and 25-month-old mice. In both age-groups, the fatigue resistance was increased to the same extent after overload ( $P < 0.01$ ), despite unaltered SDH activity and attenuated angiogenesis. Interestingly, the SDH activity for a given fibre size was higher in overloaded than control muscles. Resveratrol supplementation had no significant effect on hypertrophy, capillarisation, or fatigue resistance. Conclusion: The attenuated angiogenesis during overload may contribute to the attenuated hypertrophic response in old age. Neither was rescued with resveratrol. The dissociation between changes in SDH activity and fatigue resistance with age and overload suggests that other factors than oxidative capacity and capillarisation are the prime determinants of fatigability determined in our test. s.b.ballak@vu.nl References: Ballak, S.B., Jaspers, R.T., Deldicque, L., Chalil, S., Peters, E.L., de Haan, A. and Degens, H., 2015. Blunted hypertrophic response in old mouse muscle is associated with a lower satellite cell density and is not alleviated by resveratrol. *Exp Gerontol.* Feb; 62: 23-31. Slivka, D., Raue, U., Hollon, C., Minchev, K. and Trappe, S., 2008. Single muscle fiber adaptations to resistance training in old (>80 yr) men: evidence for limited skeletal muscle plasticity. *Am J Physiol Regul Integr Comp Physiol.* 295, R273-80.

## A COMPARISON OF ELASTIC BAND-BASED HIGH-SPEED POWER TRAINING AND TRADITIONAL LOW-SPEED STRENGTH TRAINING ON COGNITIVE FUNCTION, PHYSICAL PERFORMANCE AND MUSCLE STRENGTH IN OLDER WOMEN WITH MILD COGNIT

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1. Introduction It is known that exercise increases muscular strength and functional ability. Particularly for older adults, one of the important roles of exercise is improving cognitive function. Many studies demonstrated the effect of various exercise, the effect of resistance training that had been emphasized to maintain and improve cognitive function among elderly. In this study, after the 12 weeks of HSPT with elastic band training, cognitive function, body composition, muscular strength, functional ability of older adults with MCI were measured to demonstrate the effectiveness of elastic band-based HSPT. 2. Method Fifty eight women aged over 65 years were recruited from silver academy college of Y church in Seoul, and only thirty participants met our criteria. Participants were randomly assigned into an elastic band-based high-speed power training (HSPT) group ( $n = 14$ , age =  $75.0 \pm 0.9$  y), a low-speed strength training (LSST) group ( $n = 9$ , age =  $76.0 \pm 1.3$  y), and a control group (balance and tone,  $n = 7$ , age =  $78.0 \pm 1.0$  y). Twelve weeks of one hour exercise program was provide twice a week for HSPT group, LSST group and CON group conducted balance and tone exercise for 12 weeks. 3. Results The result show significant increase in change rate of cognitive function, physical function, and muscle strength. For cognitive function, change rate of Mini Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) showed significant increase in both HSPT and LSST compared to control group (MMSE: HSPT vs CON, 20.94 % vs -5.11 %,  $p < 0.05$ ; LSST vs CON, 13.83 % vs -5.11 %,  $p < 0.05$ , MoCA: HSPT vs CON, 30.40 % vs -2.70 %,  $p < 0.05$ ; LSST vs CON, 8.18 % vs -2.70 %,  $p < 0.05$ ). For the physical functions, change rate of SPPB scores increased significantly in HSPT and LSST compared to control group as well (HSPT vs CON, 48.74 % vs 9.37 %,  $p < 0.05$ ; MoCA: HSPT vs CON,

17.56 % vs 9.37 %,  $p < 0.05$ ). 4. Discussion In 12 weeks of elastic band-based training, HSPT showed a great improvement in older adults with MCI than LSST as similar to the results of previous studies (Henwood et al., 2008; Sayers and Gibson, 2010; Wallerstein et al., 2012) although both trainings were effective in improving cognitive function, physical function and muscle strength. Taken together, elastic band-based HSPT is more efficient and safer way to treat older adults with MCI than LSST. 5. Reference Henwood, T.R., Riek, S., Taaffe, D.R., 2008. Strength versus muscle power-specific resistance training in community-dwelling older adults. *J. Gerontol. A Biol. Sci. Med. Sci.* 63, 83–91. Sayers, S.P., Gibson, K., 2010. A comparison of high-speed power training and traditional slow-speed resistance training in older men and women. *J. Strength Cond. Res.* 24, 3369–3380. Wallerstein, L.F., Tricoli, V., Barroso, R., Rodacki, A.L., Russo, L., Aihara, A.Y., Da Rocha Correiafernanandes, A., De Mello, M.T., Ugrinowitsch, C., 2012. Effects of strength and power training on neuromuscular variables in older adults. *J. Aging Phys. Act.* 20, 171–185. Songw3@snu.ac.kr

## Mini-Orals

### MO-PM20 Physiology: Muscle damage, Hypoxia

#### EFFECT OF 3 WEEKS COMBINED 'LIVE HIGH-TRAIN LOW' EXPOSURE WITH HEAT INTERVAL TRAINING IN TRAINED RUNNERS

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**Introduction** Recent research has shown promising physiological and performance effects of living at altitude and training in the heat during short-term training camps in team sport athletes (Buchheit et al., 2013). Currently, no studies have confirmed these findings or extended this research to well-trained endurance athletes. The present study examined the performance and physiological adaptations to 21 days of high-intensity interval training in normobaric hypoxia 'live high-train low' (LHTL,  $\geq 12$  h/day at 3000m) combined with a hot environment (32°C, 55% RH), compared to training in a hot environment only or temperate conditions (14°C, 55% RH). **Methods** Twenty seven well-trained middle-distance runners (mean  $\pm$ SD; age 29.8  $\pm$ 6.9 y,  $\text{VO}_2\text{peak}$  64.2  $\pm$ 7.7 ml/kg/min) completed three weeks (12 sessions) of interval training in a matched group experimental design. Participants were assigned to one of three conditions: LHTL plus heat training (LHTL+HOT; n=10), heat training only (HOT; n=9) or living and training in temperate conditions (Control; n=8). Following the exposure period, all participants completed 3 weeks taper in temperate conditions. A 3-km time trial was completed prior to, immediately following the exposure period, and after the 3 weeks taper. Haemoglobin mass (Hbmass), and a heat response test (45min run at 65% $\dot{V}\text{O}_2\text{peak}$  + 30min seated rest; 32°C, 55%RH) were measured pre, immediately post, and one and three weeks into the taper. **Results** There were no differences in performance between any groups immediately following the 3 week exposure; however, performance improved in the HOT group (mean  $\pm$ 90%CL; -3.3 $\pm$ 1.3%) following the 3 week taper. Conversely, there were no taper-induced changes in performance in either the LHTL+HOT (-0.6 $\pm$ 1.4%) or Control (-0.2 $\pm$ 0.9%) groups. Hbmass increased during 3 week exposure period in LHTL+HOT (3.8 $\pm$ 1.8%) and remained elevated during the following 3 weeks. During the heat response test, heart rate was reduced during both exercise (-6.7 $\pm$ 1.7%) and recovery (-5.5 $\pm$ 2.1%) in the HOT group immediately following the exposure period, but returned to baseline by the end of the 3 week taper. **Discussion** Three weeks of interval training in the heat improved 3km run time-trial performance. The addition of LHTL to the heat training enhanced haematological adaptations, but did not improve 3km time-trial performance. The lack of performance improvement contrasts with findings by Buchheit et al. (2013), though these team sport athletes were of lower starting training status than the present athletes. Future studies should examine the factors that might determine physiological and performance adaptations to training camps in heat and/or hypoxic conditions. **References** Buchheit M, et al (2013) *Br J Sports Med* 47 Suppl 1: p. 159-69. Contact erin.mccleave@nswis.com.au

#### METABOLIC RESPONSES TO ACUTE HYPOXIA AND MODERATE INTENSITY NORMOXIC EXERCISE IN HUMANS

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1. Centre for Sport Exercise Science and Medicine. University of Brighton, UK. **Introduction:** Acute exposure to hypoxic conditions at rest can alter metabolism and fuel oxidation in humans. Specifically increases in metabolic rate and greater fat oxidation immediately post exposure has been reported (Workman & Basset, 2012). These findings highlight hypoxic induced alterations that may have important implications for weight loss strategies. The primary aims of this investigation were to; characterise the metabolic response of an acute hypoxic exposure at rest following the ingestion of a high lipid drink, and to; assess the response of an acute hypoxic exposure at rest coupled with a post exposure moderate intensity exercise bout in normoxic conditions. **Methods:** Eight individuals (7 males, 1 female; age, 22  $\pm$  5 yr; BMI 24  $\pm$  4 kg/m<sup>2</sup>) participated in all trials. Participants consumed a high lipid drink prior to 60 minutes of normoxic (NORM) or hypoxic (HYP) rest on separate occasions. Following the rest period participants undertook 60 minutes of moderate intensity cycling exercise at 60% heart rate reserve in normoxic conditions (NORM EX & HYP EX). Measures of metabolic rate, fuel oxidation and blood lipid measures were assessed for a period of 240 minutes. A control trial (CON) was undertaken during which participants consumed a high lipid drink and rested for 240 minutes in normoxic conditions. **Results:** Acute hypoxic exposure induced significant increases in energy expenditure (+ 22  $\pm$  11 kcal.hr<sup>-1</sup>) ( $p \leq 0.05$ ) and CHO oxidation (+ 0.17g.min<sup>-1</sup>) ( $p \leq 0.05$ ) compared to normoxia during 60 minutes of rest. Pre exercise hypoxic rest did not alter metabolic rate (7.01  $\pm$  3.61 & 8.2  $\pm$  3.03 kcal.min<sup>-1</sup>) and fuel oxidation (0.99  $\pm$  0.57 g.min<sup>-1</sup> & 1.01  $\pm$  0.72 g.min<sup>-1</sup>) during moderate intensity exercise in normoxic conditions compared to rest in normoxia prior to exercise. Measures of free fatty acids (+ 0.18  $\pm$  0.06 mmol/L & +0.27  $\pm$  0.19 mmol/L) and triglycerides (+ 0.11  $\pm$  0.20 mg.dL<sup>-1</sup> & +0.10  $\pm$  0.18 mg.dL<sup>-1</sup>) increased over time in NORM EX and HYP EX ( $p \leq 0.05$ ) yet did not differ between conditions ( $p > 0.05$ ) throughout the experiment. **Conclusions:** An acute hypoxic exposure was sufficient in inducing increases in metabolic rate through greater CHO oxidation at rest. The consumption of a high lipid meal prior to exposure did not alter this hypoxic induced effect. Greater fat oxidation and increased metabolic rate following an acute hypoxic exposure did not occur during moderate intensity exercise as it has been shown to do during post hypoxic rest (Workman & Basset, 2012) most likely due to the intensity of exercise and length of hypoxic exposure. Email: bd27@uni.brighton.ac.uk **References:** Workman, C., & Basset, F. a. (2012). Post-metabolic response to passive normobaric hypoxic exposure in sedentary overweight males: a pilot study. *Nutrition & Metabolism*, 9(1), 103.

## THE RELATIONSHIP BETWEEN CHANGES IN BRACHIAL-ANKLE PULSE WAVE VELOCITY AND BLOOD PRESSURE AFTER SHORT-TERM HYPOBARIC HYPOXIC TRAINING

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**Introduction** Recently, we have observed that hypobaric hypoxic exercise could induce more beneficial vasculature adaptations, such as a decrease in brachial-ankle pulse wave velocity (baPWV), which is an index of arterial stiffness, and in blood pressure especially during exercise within relatively short training period even in healthy young subjects (Ogita 2011, 2013). Furthermore, it seems that there are large individual differences in changes in these variables induced by training. However, it has not been clarified what influences on the individual differences. Therefore, present study aimed to examine whether the changes in baPWV after short-term hypobaric hypoxic training are related to initial (pre-training) level, and also are associated with the changes in blood pressure at rest. **Methods** The subjects were 41 healthy male adults (22±2 yrs). They had a 30 min aquatic exercise at the intensity of around 50%VO<sub>2</sub>max for 5 consecutive days or 4 of 5 days under hypobaric hypoxic conditions corresponding to 2000m above sea level. Before and after the training, systolic (SBP), diastolic (DBP) and mean blood pressure (MBP) at rest and baPWV were determined. All post-training tests were accomplished over 2nd to 3rd day after their last exercise session. **Results** After the training, baPWV significantly decreased, which means that arterial stiffness improves within relatively short period (5 days). A negative correlation was found between baPWV at baseline and changes in baPWV after the training. Also, SBP, DBP and MBP at baseline were significantly correlated to baPWV, respectively. However, all of SBP, DBP, and MBP showed a tendency to decrease, but it was not statistically significant. Consequently, no significant correlations were found between changes in baPWV and blood pressure at baseline or changes in blood pressure (i.e. all of SBP, DBP, and MBP). **Discussion/Conclusion** These findings suggest that short-term hypobaric hypoxic training improves baPWV as an index of arterial stiffness and that changes in baPWV after the training depends on baPWV at baseline in healthy men, but are not related to resting blood pressure at baseline or to changes in blood pressure after the training. **Reference** Ogita, F., Kurobe, Z., Huang, G., Ozawa, A., Nagira, M., Nishiwaki, T., Tanaka, H., Tamaki, H., Takekura. (2011) Effects of intermittent hypobaric hypoxic exercise of 5 days on blood pressure and vascular adaptations. Book of Abstracts, 16th ECSS : 546. Ogita, F. (2013) Effects of intermittent hypobaric hypoxic exercise on cardiovascular adaptations. J.Phys.Fitness Sports Med. 2:341-345. Contact; ogita@nifs-k.ac.jp

## REACTIVE OXYGEN SPECIES AND DNA INTEGRITY IN SOME IRAQ ATHLETICS FEMALE

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Do notEffect of physical exercises on human health depends on the time and the hardness of the exercises. This effect could improve the health of the athletics by decreasing the risk of mortality, and increase the fitness compared to no fitness for low exercise practicing. During the exercises, the metabolism rate increases greatly, as quantified by oxygen consumption and heat production, which enhanced generation of reactive oxygen species (ROS). ROS describe both oxygen-centered free radical, and reactive non-radical derivatives oxygen. To overcome the misunderstanding on the role of ROS on cell damaging, we studied the effect of exercises on the integrity of the DNA of female from the Iraqi team for bicycles. The studied (12) subjects were divided to two groups, Group one (6 female) from Iraqi team for bicycle, group two (6 female) un-athletics as control with mean age ( 22.5 ±1.48) for both groups, The two group were sex and age matched. DNA samples were extracted from the blood of the both groups by using mini-prep kit (Promega), while Malodialdehyde levels were measured by using colorimetric method. Results revealed an effect of ROS on the integrity of the DNA associated with an insignificant increment of Malodialdehyde levels in the athletic group as compared to control. As a conclusion, to decrease the effect of ROS on the integrity of DNA the time and the hardness of the exercises must be set carefully and there nutrition must be healthy. insert authors here

## MAXIMAL LACTATE STEADY STATE DURING STEP TESTING IN NORMOXIA AND ACUTE NORMOBARIC HYPOXIA

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**Introduction:** The step test (ST) is frequently applied in performance diagnosis and might be used for testing during mountaineering. Further, analysis of blood lactate (La) during exercise, the determination of the maximal lactate steady state concentration (MLSS) and the corresponding workload at defined La concentrations (like 4-mmol/l) (Heck et al. 1985) are widely used since many years. MLSS, however, has not been determined during ST in normoxia (NN) and hypoxia so far. The aims of this study were 1) to determine MLSS during several constant load step tests in NN and in two hypoxic conditions (15%O<sub>2</sub> and 17%O<sub>2</sub>, respectively (NH15, NH17)), and 2) to analyse the validity of the determination of the corresponding work load (step frequency (SF)) at MLSS (SF-MLSS) from one single incremental ST at NN and altitude. **Methods:** 12 subjects (4f, 8m, 22.5±2.6yrs, 172.0±10.9cm, 69.1±12.2kg) performed an incremental ST (SF: 66, 84, 102, 114, 132, 144 bpm, 5 min duration/SF, 1 min rest between SFs) until exhaustion in NN, NH17, and NH15, respectively, with determination of La at the end of each SF. Thereafter, n=3 to 5 30-minute constant-load ST for the determination of MLSS and the corresponding SF-MLSS were performed at each altitude, starting with the respective SF corresponding to 4 mmol/l La concentration during incremental step test and then either increasing or reducing workload of each 30-min constant-load test by 3 bpm until MLSS was clearly defined (e.g.: La did not increase any more than 1 mmol/l during the last 20 min). Parameters included maximum values of SF (SFmax), La (Lamax), heart rate (HRmax), V'O<sub>2</sub>peak, and RERmax and the respective values at MLSS. **Results:** SFmax, Lamax, V'O<sub>2</sub>peak, Hfmax and RERmax did not differ between NN, NH17 and NH15 (data not shown). MLSS was significantly higher in NH15 compared to NH17 and NN (MLSS: NN: 3.63±0.94; NH17: 4.06±0.85; NH15: 5.01±1.06 [mmol/l]). SF-MLSS was significantly reduced in NH15 compared to NH17 and NN (SF-MLSS: NN: 110.3±12.1; NH17: 107.6±13.5; NH15: 102.2±11.5 [bpm]). HR-MLSS, VO<sub>2</sub>-MLSS, and RER-MLSS were unaffected by altitude (data not shown). Step frequency at MLSS determined by constant-load stepping correlated significantly with step frequency corresponding to 4 mmol/l lactate concentration during incremental step test at both altitude conditions, but not at NN (NN: r=0.32, NH17: r=0.82, NH15: r=0.79). **Discussion:** MLSS might be determined by means of incremental ST at moderate to high altitude, and ST might be used for performance diagnosis under field conditions in the mountains. Alterations in La metabolism at altitude, however, have to be taken into account. **References:** Heck, H.; Mader, A.; Hess, G.; Mücke, S.; Müller, R.; Hollmann, W. (1985): Justification of the 4-mmol/l lactate threshold. Int J Sports Med 6 (3), S. 117–130.

**NO EFFECT OF DIETARY NITRATE ON THE HUMAN DIVING RESPONSE IN DRY AND WET APNEAS**

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1:Environmental Physiology Group, Mid Sweden University, Sweden. 2:LHL-Klinikkene Røros, LHL Health, Norway. 3: Swedish Winter Sports Research Centre, Mid Sweden University, Sweden.

**Introduction** Ingestion of dietary nitrate has been shown to increase dry apnea duration (Engan et al., 2012; Collofello et al., 2014) and reduce arterial oxygen saturation (SaO<sub>2</sub>) during fixed duration apneas, but conflicting results have been presented with wet apneas (Schiffer et al., 2014) and the underlying mechanisms have not been identified. Dietary nitrate might influence the oxygen conserving diving response. The aim of this study was to determine the effect of dietary nitrate on the diving response during apnea and simulated diving by facial immersion (wet apneas; WA). **Methods** Five men and three women aged 27 (9.5) years consumed on separate days either concentrated beetroot (BR; 5 mmol NO<sub>3</sub><sup>-</sup>) or placebo (P; 0.03 mmol NO<sub>3</sub><sup>-</sup>) juice ~2.5 hours before tests in a weighted order. Subjects performed apneas (A) and apneas with face immersion in 15 °C water (WA), of equal duration during prone rest. HR, SaO<sub>2</sub>, skin blood flow and mean arterial blood pressure were measured continuously across the tests. Results Baseline HR (BR: 71±17 bpm and PL at 74±15 bpm; NS) and skin blood flow (BR: 5.6±5.9 p.u and PL at 5.0±5.1 p.u) were similar between BR and PL (NS), while MAP was reduced with BR at 72±11 mmHg compared to PL at 98±5 mmHg (P<0.05). During A and WA, the HR reduction from baseline, characterizing the diving response, was present with both BR and PL. The HR reduction tended to be enhanced with WA in both BR and PL conditions. The magnitude of the HR reduction during A compared to WA was not different between BR and PL (p=0.58). Skin blood flow was reduced in a similar way during A and WA in both BR and PL conditions. The SaO<sub>2</sub> reduction from baseline tended to be less pronounced with WA compared to A in BR (1.3±2.0 %; P= 0.08) while it was not different between WA and A in PL (0.49±2.0 %; P=0.48). The magnitude of SaO<sub>2</sub> reduction during A compared to WA was not different between BR and PL (P=0.36). **Conclusion** BR has no effect on the oxygen conserving diving response in dry or wet apneas. Such an effect can thus not explain the conflicting results concerning arterial oxygen saturation and apneic duration in previous studies. **References** Collofello B., et al. 2014. Acute Dietary Nitrate Supplementation Decreases Systolic Blood Pressure and Increases Dry Static Apnea Performance in Females. *Journal of Exercise Physiology Online* 17. Engan, H.K., et al. 2012. Acute dietary nitrate supplementation improves dry static apnea performance. *Respir Physiol Neurobiol* 182, 53-59. Schiffer T.A., et al. 2013. Effects of dietary inorganic nitrate on static and dynamic breath-holding in humans. *Respir Physiol Neurobiol* 185, 339-348.

**Mini-Orals****MO-PM22 Physiology: Cardiovascular physiology****EFFECT OF AGE ON BLOOD FLOW KINETICS DURING PLANTAR FLEXION EXERCISE**

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**Introduction** The increase in leg blood flow during exercise is attenuated in older adults, particularly at a given relative intensity. At absolute exercise intensities, the ageing effect is less evident with no apparent difference in steady state blood flow (I). The extent to which ageing influences blood flow kinetics during exercise is unclear. Therefore, the aim of this study was to compare the magnitude and kinetic parameters of the leg blood flow response, between younger and older adults, during plantar flexion exercise at the same absolute intensity. **Methods** Younger (Y: age 25±3 y, n=11) and older (O: age 68±5 y, n=11) participants underwent measures of supine resting leg blood flow and post-occlusive reactive hyperaemia using venous occlusion plethysmography (VOP). Participants then completed 2 x 5min bouts of intermittent plantar flexion exercise, 7 days apart, with their dominant leg while seated in an isometric dynamometer. Each bout included 60 contractions that were 2s and separated by 3s rest. Contraction intensity was 500N. Mean arterial blood pressure (MAP) was monitored at the finger. Leg blood flow was measured during the rest periods following each contraction using VOP, which required a thigh cuff (30mmHg) to be maintained throughout each bout. Blood flow data for the two trials were averaged and fitted to a triphasic model to determine the kinetic parameters of the exercise response. Results There were no differences between age groups for resting leg blood flow (O: 3.54±1.65; Y: 2.78±0.72 ml/100ml/min) or reactive hyperaemia (O: 15.05±8.21; Y: 17.03±5.37 ml/100ml/min). MAP was higher in older (98±10) compared with younger participants (80±6 mmHg) at rest, and throughout exercise. Blood flow magnitude (~45 ml/100ml/min) was not different between groups during exercise. Amplitude of the first phase of the exercise blood flow response tended to be smaller in the older (22.08±7.06) compared with younger group (29.03±9.99 ml/100ml/min, p=0.08); second phase amplitude was larger in older (15.91±5.25) than in younger (9.40±4.83 ml/100ml/min, p=0.008); and there tended to be a larger third (slow) phase amplitude in older (12.62±2.85) than in younger participants (5.13±2.84 ml/100ml/min, p=0.13). Time-delays and rate constants for each phase were not different between age groups. **Conclusion** Despite there being no difference in the magnitude of the rise in blood flow during exercise at a given absolute intensity, the kinetics of the blood flow response tended to be slower in older adults, with a smaller initial rise in blood flow (non-sig) at the onset of exercise that was offset by larger later-phase amplitudes. **Reference:** 1. Donato et al. *Am J Physiol Heart Circ Physiol* 290: H272-H278, 2006 **Contact:** caskew@usc.edu.au

**THE EFFECTS OF CONTINUOUS AND INTERVAL AEROBIC EXERCISE ON BLOOD PRESSURE**

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**Introduction** Exercise and physical activity are one of the non-drug methods which are effective on the reduction of the blood pressure. The present study was aimed to compare the effect of continuous and interval aerobic exercise on blood pressure in hypertensive middle-aged women. **Methods** Twenty hypertensive women volunteered to participate in this quasi-experimental study. Having filled the questionnaire, the subjects were randomly divided into two groups of continuous aerobic exercise (n=10, age: 58.1, ±1.94, wt: 72.93±3.56) and interval aerobic exercise (n=10, age: 56.4±2.5, wt:70±5.39). The continuous aerobic exercise group performed aerobic exercise training at the intensity of 60% of their maximum heart rate. The interval aerobic exercise group performed its variable-intensity activities including 2 minutes of cycling with the intensity of 50% and 1 minute with the intensity of 70% of their maximum heart rate. Heart rate and systolic and diastolic blood pressure were measured before and after the training every 30 minutes for 10 hours. **Results** The

results of the study revealed that one session of continuous and interval aerobic exercise has no significant effect on the mean arterial blood pressure (MAP) of middle-aged women. Discussion Although one session of continuous and interval aerobic exercise had no significant effect on the mean arterial blood pressure (MAP) of middle-aged women, the decrease of mean arterial pressure lasted for 10 hours and the reduction was more in the continuous aerobic exercise group. This shows that the aerobic exercise especially the continuous one helps reduce blood pressure of hypertensive patients for some hours following the exercise. References Rahimian, Z., R. Hosseini, J. Ariannejad, 2010. 'The effects of exercise and diet on cardiovascular risk factors - vascular and blood pressure in overweight women, obese and Hypertensive'. Iranian Journal of Endocrinology and Metabolism, 4(12): 376-384.' Khoshdel, A., B. Dormanesh, M. Noorifard, 2011. 'New account behind the ups and downs of blood: Clinical and epidemiological methods and values of blood pressure monitoring in high-risk groups'. Journal of Army University of Medical Sciences, 2(9): 118-129. Jeremiah, G., 2011. 'Post-exercise hypotension in brief exercise'. A Thesis The Faculty of the Department of Kinesiology, Recreation, and Sport, western Kentucky University. Spragg, Carly, 2009. 'Post Exercise Hypotension and Blood Pressure Circadian Rhythm in Prehypertensive Older Adults.' Diss. University of Toronto. Wilmore, J., D. Cassell, 2005. 'Exercise Physiology and activities. ahoseinzadeh22@yahoo.com

## ASSESSMENT OF CARDIOVASCULAR ADJUSTMENTS DURING MOTORCYCLE RIDING

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Introduction Hemodynamic parameters, such as Cardiac Output (CO) and Stroke Volume (SV), have never been studied in motorcycle racing. This because the measurement of these variables is hampered by difficulties related to the particular environment of motorcycle performance, which can be considered an extreme condition. Moreover, these parameters need the availability of a non-invasive and reliable portable cardiovascular measurement systems. Indeed, the only data available are about Heart Rate (HR), which increases to 90-95% of maximum, despite the supposed low energy requirements of motorcycle riding (Kontinen T. et al. 2007; D'Artibale E. et al. 2007). The aim of this study was to measure hemodynamics of enduro- motorcycling pilots during real motorcycle race by means of portable impedance cardiograph. Methods Seven male elite motorcycle riders performing regional and national competitions on enduro motorcycles were studied. Hemodynamics was assessed by means of a portable impedance cardiograph (New Core, 2C Technologies Inc., Cagliari, Italy, Tocco et al. 2013). Data were collected at rest, throughout 10 minutes of motorcycle race at maximum speed possible. Results The comparison between rest and exercise showed a significant increase in hemodynamic parameters. In detail, increments in both HR ( $159.8 \pm 6.2$  vs  $94.8 \pm 14.8$  at rest,  $p < 0.05$ ) and SV ( $79.2 \pm 16.8$  vs  $62.1 \pm 10.1$  at rest  $p < 0.05$ ) were observed, thereby leading to a CO elevation ( $12.7 \pm 2.9$  L/min vs  $5.8 \pm 1.02$  L/min at rest,  $p < 0.05$ ). Conclusions Data obtained show that enduro motorcycle riding leads to significant increments in both HR and SV. While the former fact was already known, the latter is a new finding of the present investigation. The significant SV response can be the consequence of a substantial increase in cardiac contractility which can be ascribed to a sympathetic activation, as testified by the contemporary increase in HR. It is possible to speculate that the heavy muscular work of the upper and lower limbs activates the exercise pressor reflex, thereby causing sympathetic activation. References Kontinen T, Häkkinen K, Kyröläinen H. (2007). J Sports Sci. Jul;25(9):995-9. D'Artibale E., Tessitore A., Tiberi M., Capranica L. (2007). Int J Sport Med. Aug;28(8):662-6. Tocco F, Marongiu E, Pinna M, Roberto S, Pusceddu M, Angius L, Migliaccio G, Milia R, Concu A, Crisafulli A.(2013). Acta Physiol (Oxf). Feb;207(2):290-8. contact: virginia.pinna@gmail.com

## EFFECTS OF MENSTRUAL CYCLE PHASE ON THE DYNAMICS OF CARDIOVASCULAR CONTROL DURING AN INCREMENTAL STRESS-TEST TO VOLITIONAL EXHAUSTION

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Introduction During incremental exercise to  $VO_{2max}$ ,  $O_2$  delivery is expressed through cardiac output (Q), (a function of stroke volume (SV) and heart rate (HR)) and capacity to extract oxygen at the muscle,  $a-vO_{2dif}$ .  $VO_{2max}$  is associated with the attainment of  $Q_{max}$  and  $a-vO_{2difmax}$ , yet SV response is less clear. How SV responds in female participants is unclear, with limited data reflecting menstrual function and cardiovascular control. Therefore the purpose of this study was to examine the effects of menstrual cycle phase on cardiovascular control during a  $VO_{2max}$  test. Method 15 physically active participants of which  $n=9$  formed the non-oral contraceptive group (n-OC) (age  $20.6 \pm 1.6$ yr, height  $169.9 \pm 6.4$ cm, mass  $68.7 \pm 7.9$ kg) who displayed regular menstrual function. Remaining 6 participants formed the oral-contraceptive control group (OC) (age  $21.7$ yr  $\pm 2.1$ , height  $168.1 \pm 6.8$ cm, mass  $61.6 \pm 6.8$ kg). All reported to the laboratory on 5 separate occasions for the determination of  $VO_{2max}$ . All trials completed on an electronically braked cycle ergometer (60-80 rpm) with work-rate increasing by  $0.42$  W/s. Cardiovascular responses were recorded using impedance cardiography with parameter variations analysed and compared with those measured during the calibration procedure. Four of the visits corresponded to menstruation (MEN), mid-follicular (mFOL), mid-luteal (mLUT) and immediately pre-menstrual (pMEN), with the 5th a familiarization trial. For OC, all trials were completed according to a pseudo menstrual cycle. Also recorded for the n-OC were progesterone and  $17\beta$ -oestradiol. Results Significant differences were found for Q between OC and n-OC during MEN at 30% ( $P=0.047$ ), 70% ( $P=0.048$ ) and 100%  $VO_{2max}$  ( $P=0.036$ ), with a significant difference also observed for  $Q_{max}$  ( $P=0.01$ ) between OC ( $16.5 \pm 1.5$  l/min) and n-OC ( $20.3 \pm 3.3$  l/min). Additionally significant differences were identified during MEN for  $a-vO_{2dif}$  between OC and n-OC at 100%  $VO_{2max}$  ( $P=0.04$ ), with a further significant difference observed for  $a-vO_{2difmax}$  for OC ( $0.16 \pm 0.02$ ml) and n-OC ( $0.13 \pm 0.01$ ml) and  $SV_{max}$  OC ( $96.7 \pm 11.2$ ml), n-OC ( $116.3 \pm 19.7$ ml) ( $P=0.03$ ). Discussion Irrespective of phase both n-OC and OC exhibited typical responses for both SV and  $a-vO_{2dif}$  levelling out at 40% and 80%  $VO_{2max}$  respectively. Lack of difference between groups and phases for SV, Q and  $a-vO_{2dif}$  suggests that although oestrogen is implicated in cardio-protection it does not affect cardiovascular control. The significant difference in MEN for Q and  $a-vO_{2dif}$  deserves further investigation and may be associated with blood volume. viviane.merzbach@anglia.ac.uk

## EFFECT OF LIFESTYLE MODIFICATION ON PULSE PRESSURE AMPLIFICATION IN OVERWEIGHT AND OBESE MEN

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Introduction: Recently, it has been demonstrated that central to peripheral pulse pressure amplification (PPA) is more relevant for predicting cardiovascular disease than the traditional risk factors (i.e., blood pressure) (Benetos et al., 2010). In obese individuals, PPA is low as compared with age-matched normal weight counterparts (Pierce et al., 2013). However, it is unclear that the effect of lifestyle modification on PPA in overweight and obese individuals. The purpose of this study was to investigate whether lifestyle modification increases PPA in



overweight and obese men. Methods: Thirty-three overweight and obese men (age:  $51 \pm 1$  years, BMI:  $28.5 \pm 0.3$  kg/m<sup>2</sup>) completed a 12-week lifestyle modification program, combining regular aerobic exercise and dietary modification. Before and after the program, we measured anthropometric variables, aortic and femoral pulse pressure and PPA. PPA was calculated as percentage ratio of the femoral pulse pressure to the aortic pulse pressure. Results: The 12-week lifestyle modification led to marked weight loss (from  $82 \pm 1$  to  $70 \pm 1$  kg,  $P < 0.001$ ). After the program, aortic pulse pressure decreased significantly (from  $43 \pm 1$  to  $39 \pm 1$  mmHg,  $P = 0.001$ ), while femoral pulse pressure remained unchanged (from  $49 \pm 1$  to  $46 \pm 1$  mmHg,  $P = 0.060$ ). PPA significantly increased after the program (from  $115 \pm 2$  to  $120 \pm 1$  %,  $P < 0.001$ ). There was no significant correlation between changes in weight and those in PPA ( $r_s = 0.026$ ,  $P = 0.886$ ). Discussion: We demonstrated for the first time that the 12-week lifestyle modification increases PPA in overweight and obese men. Although lifestyle modification caused marked weight loss (approximately 15 %), changes in weight did not correlate with those in PPA, indicating that weight loss is not a direct mechanism underlying lifestyle modification-induced increases in PPA. Further investigations are needed to clarify the mechanisms underlying lifestyle modification-induced increases in PPA in overweight and obese men. References: Benetos A, Thomas F, Joly L, et al. (2010). *J Am Coll Cardiol* 55(10):1032-7. Pierce GL, Zhu H, Darracott K, et al. (2013). *Am J Hypertens* 26(1):20-6. Contact: yoshikawat@live.jp

## HEART RATE VARIABILITY: CONVENIENCE, MEASUREMENTS AND MONITORING. REVIEW ARTICLE

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Heart Rate Variability: convenience, measurements and monitoring a review. Pol Gene-Sanahuja1. 1Catalonian High Performance Rowing Center, Banyoles, Spain. Autonomous Nervous System (ANS) balances actions of the sympathetic nervous system (SNS) and parasympathetic nervous system (PNS). At vagal state, stimulations are provided through the SNP, while in an anxiety stress or active state, the stimulation of the SNS is higher1. Increasing SNS or diminished PNS results in cardio-acceleration, conversely, lower SNS or higher PNS activity causes cardio-deceleration2, the connexion of both, controls the heart rate (HR)3. Scheduled exercise induces stress to athlete with an over-reaching response after an appropriate recovery providing gains in performance, as described by the super-compensatory theory4. Consequently the use of heart rate variability (HRV) to indirectly detect ANS status in response to training is in continues to grow5,6 evaluating training efficacy, recovery status, load impact, over training and illness or injury7. A growing body of evidence supports the utility of HRV's as good instrument to predict physical performance in athletes, further changes in vagal-derived indices of HRV have been suggested to indicate negative and positive adaptations to endurance training regimens5,6. Consequently, some parameters have been studied from unsatisfactory recovery procedure and fitness performance, giving an individualized recovery-stress index to athletes. HR monitors, specifically designed systems or smart phone applications give an easier way to assess HRV collecting beat-by-beat time, known as RR interval. So far, spectral and time interpretations were used to assess ANS responses7, but a main reliable value still undefined, the aim of this review was to define which are the more important HRV parameters and how to monitor them in the sport specific field using new technology instruments. References: 1. Achten J, Jeukendrup A. Heart Rate Monitoring: Applications and Limitations. *Sports Med.* 2003 7:517 2. Acharya U, Joseph KP, Kannathal N, Lim C, Suri J. Heart Rate Variability: a review *Med Bio Eng Comput.* 2006 44:1031 3. Buchheit, M. Monitoring training status with HR measures: do all roads lead to Rome? *Frontiers in Physiology.* 2014 5:73 4. Stanley J, Peake J, and Buchheit, M. Cardiac Parasympathetic Reactivation Following Exercise: Implications for Training Prescription. *Sports Med.* 2013 43:1259 5. Plews D, Laursen P, Kilding A, and Buchheit M. Heart Rate Variability and Training Distribution in Elite Rowers. *IJSP.* 2014 Nov;9(6):1026 6. Plews D, Laursen P, Le Meur Y, Hausswirth C, Kilding A, and Buchheit M. Monitoring Training With Heart Rate Variability: How Much Compliance Is Needed for Valid Assessment?. *IJSP.* 2014 Sep; 9(5):783 7. Halson, S. Monitoring Training Load to Understand Fatigue in Athlete. *Sports Med.* 2014 44 (Suppl 2):S139

## Mini-Orals

### MO-PM24 Physiology: Mixed session

#### MODERATE EXERCISE IMPROVES COGNITIVE FUNCTION EVEN UNDER SEVERE HYPOXIA

Komiyama, T.1, Katayama, K.2, Ito, Y.2, Sudo, M.3, Ishida, K.2, Higaki, Y.1, Ando, S.4

1: Fukuoka Univ. (Fukuoka, Japan), 2: Nagoya Univ. (Nagoya, Japan) 3: Meiji Yasuda Life Foundation of Health and Welfare. (Tokyo, Japan) 4: The University of Electro-Communications. (Tokyo, Japan)

Introduction It is well known that acute moderate exercise improves cognitive function. Recently, we demonstrated that moderate exercise improved cognitive function under moderate hypoxia (FIO<sub>2</sub>: 0.15) (Komiyama et al., 2015). In contrast, severe hypoxia obviously produces physiological disorders because of reduction in available oxygen. Hence, severe hypoxia may impair cognitive function. However, it is unclear how moderate exercise affects cognitive function under severe hypoxia. The purpose of this study was to determine the effects of acute exercise under severe hypoxia on cognitive function. Methods Eight subjects completed two trials under either normoxia or severe hypoxia (FIO<sub>2</sub>: 0.12~0.13) on a different days. They undertook preliminary test to assess peak oxygen uptake (VO<sub>2peak</sub>) by a cycle ergometer under both normoxia and hypoxia, respectively. At the beginning of the experiment, the subjects performed the cognitive task at rest. Then, after a 5 min warm-up (30%VO<sub>2peak</sub>), they cycled the ergometer at moderate intensity (50%VO<sub>2peak</sub>) for 15 min. Cognitive tasks were started 5 min after the start of exercise at moderate intensity. Cognitive task consisted of Spatial Delayed Response task and GO/NOGO task, which required working memory and executive function. Cognitive performance was assessed by speed of response (reaction time) and accuracy. Cerebral oxygenation was assessed by near infrared spectroscopy. Pulse oximetry saturation (SpO<sub>2</sub>) and cerebral oxygenation were monitored throughout the experiment. Results SpO<sub>2</sub> and cerebral oxygenation were significantly lower under hypoxia than normoxia ( $p < 0.01$ ). Moreover, exercise significantly decreased SpO<sub>2</sub> and cerebral oxygenation under hypoxia relative to normoxia ( $p < 0.01$ ). However, reaction time in the cognitive task decreased during exercise as compared with rest under both conditions ( $p < 0.01$ ). The degree of decrease in reaction time was not different between normoxia and hypoxia. Neither exercise nor hypoxia altered the accuracy in the cognitive task. Discussion Severe hypoxia substantially induced lower available oxygen during exercise than normoxia. Nevertheless, cognitive function improved during exercise relative to rest under hypoxia as well as normoxia. Thus, acute moderate exercise has the beneficial effect on cognitive function even if decreased oxygen availability in the brain. We conclude that moderate exercise improves cognitive function even under severe hypoxia. References Komiyama T, Sudo M, Higaki Y, Kiyonaga A, Tanaka H, Ando S. (2015). *Physiol Behav.* 139, 290-296 Contact mt.komi51@gmail.com

**TOTAL PEPTIDE YY CONCENTRATIONS FOLLOWING SHORT TERM CONSUMPTION OF VEGETARIAN DIETS**

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Introduction Body fat, cholesterol and oxidative stress decrease following long term of vegetarian diets (Kim et al., 2012). Circulating of leptin concentrations in non-vegetarians were higher than vegetarians (Ambrosziewicz et al., 2004). However, the impact of vegetarian intake on appetite is still unclear whether short-term consumption of vegetarian diets has impact on satiety hormone like peptide YY (PYY) concentrations. Therefore, the objective of this study was to investigate the effect vegetarian diets on total PYY concentrations. Methods Fifteen males age between 19 and 21 years participated in this study, which had been approved by the local ethics committees (body mass index,  $23 \pm 2$  kg/m<sup>2</sup>; percent body fat,  $12 \pm 4$  %; percent fat free mass,  $88 \pm 4$  %; resting heart rate,  $62 \pm 11$  beat/min; systolic /diastolic blood pressure,  $122 \pm 7/68 \pm 9$  mmHg; maximum oxygen consumption,  $58 \pm 7$  ml/kg/min: mean  $\pm$  SD). This is a randomized cross-over design with two main trials separated by at least 14 days. Participants were asked to consumption either normal or vegetarian diets for ten days. Subjective feeling of hunger and fullness were measured before and after either normal or vegetarian diets. Fasting total PYY, glucose and lipid profile concentrations were assessed at the same period of time. The data were analyzed using two way repeated measures ANOVA and paired t-test. Results There was no change in circulating plasma total PYY, glucose, high density lipoprotein concentrations, body weight, body fat and subjective feeling of hunger and fullness following consumption of vegetarian diets. However, cholesterol (before:  $178 \pm 27$ ; after:  $154 \pm 28$  mg/dL,  $P = 0.04$ ) and low density lipoprotein (before:  $119 \pm 21$ ; after:  $100 \pm 24$  mg/dL,  $P = 0.02$ ) were decreased significantly following consumption of vegetarian diet. Discussion Consumption of vegetarian diet for ten days induced decreased in cholesterol and low density lipoprotein but there was no impact on total PYY and subjective feeling of hunger and fullness. References Kim MK, Cho SW, Park YK (2012). Long-term vegetarians have low oxidative stress, body fat, and cholesterol levels. *Nutrition research and practice*. Apr;6(2):155-61. Ambrosziewicz J, Laskowska-Klita T, Klemarczyk W (2004). Low serum leptin concentration in vegetarian prepubertal children. *Rocz Akad Med Bialymst*. 49:103-5.

**FAECAL CALPROTECTIN RESPONSES TO MODERATE INTENSITY EXERCISE; PILOT OBSERVATIONS.**

Hamzah, N., Chester, N.I, Scott, M.I, Doran, D.A.I

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Introduction Exercise is associated with a loss of gastrointestinal (GI) epithelial barrier integrity. Recently calprotectin, a 36-Kda cytosolic protein marker of GI inflammation has been postulated as a putative biomarker of exercise related perturbations in GI function (van Wijck et al. 2012). The aim of this study was to examine the effect of a single bout of exercise relative to rest upon faecal calprotectin (FC) expression. Methods Four healthy males (Age  $20.5 \pm 0.5$  yr; Weight  $72.6 \pm 11.2$  kg; VO<sub>2</sub> max  $4.03 \pm 0.49$  l/min) undertook a counter balanced repeated measures design of 50 minutes of rest (Control) or steady state running (~70% VO<sub>2</sub> max). Subjects were monitored for HR, core temp, RPE, and GI discomfort. Faecal samples were collected as the first void prior to and after each experimental protocol and stored at  $-80^{\circ}\text{C}$  until analysis via a quantitative rapid assay test (Bühlmann QUANTUM BLUE®). Results Physiological responses for HR, RPE, core temp, GI symptoms were increased during exercise relative to rest ( $P < 0.05$ ). Following exercise a reduction in FC was observed pre to post exercise ( $127.8 \pm 102.7$   $\mu\text{g/g}$  vs  $85.3 \pm 56.1$   $\mu\text{g/g}$ ;  $P > 0.05$ ). Conversely, during the rest protocol FC increased pre to post protocol completion ( $81.3 \pm 9.3$   $\mu\text{g/g}$  to  $117.7 \pm 11.5$   $\mu\text{g/g}$ ;  $P > 0.05$ ). Discussion FC is a neutrophil degranulation protein clinically associated with GI inflammation. Whilst detectable in faeces and plasma no reports of FC responses exist. Previous literature indicates significant elevations in plasma calprotectin after moderate intensity exercise. However, when measured in faecal samples, a reduction in calprotectin occurred after exercise. Intriguingly following the resting protocol, we observed increased FC concentrations. These observation may relate to the compartment from which calprotectin was sampled i.e. plasma vs faecal. Calprotectin is released from skeletal muscle; as such its elevation in plasma may not be attributable to GI inflammation alone. FC may thus present a more GI specific marker of inflammation although present data suggest it may be highly variable reflecting that seen in clinical populations (Lasson et al., 2015). This FC variability is perhaps due to the time gap (>8-12hrs) between protocol completion and faecal voiding. In conclusion, the utility of FC as a biomarker of exercise mediated gut inflammation remains to be fully elucidated. van Wijck, K. et al., (2012). *AJP: Gastrointestinal and Liver Physiology*, 303 (2), G155–G168. Lasson, A., et al., (2015). *J.Crohns*. doi:10.1016/j.crohns.2014.06.002.

**CARDIORESPIRATORY RESPONSES AND PEDAL FORCE DURING ONE-LEGGED EXERCISE WITH A TANDEM-BICYCLE ERGOMETER**

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*1Kawasaki University of Medical Welfare, 2Fukuyama Heisei University, 3Graduate School, Kawasaki University of Medical Welfare, 4Hirashima Institute of Technology, 5Okayama University, 6Nagoya Univers*

Purpose: The tandem-bicycle ergometer, which we recently developed has new characteristics, a swing joint with one load and a pist type. We have reported that the tandem-bicycle ergometer is a suitable apparatus to give an equal load to two subjects from sub-maximal exercise to exhaustion, which was evaluated by cardiorespiratory responses (Onodera S. et al., ECSS 2012, 2013). Even if the peak oxygen uptake of a pair is different by up to 10%, the values of peak oxygen uptake obtained during single bicycle ergometer exercise, in front or rear saddle trial during tandem bicycling ergometer exercise were not significantly different (Onodera S. et al., ECSS 2014). The purpose of this study was to investigate a comparison of cardiorespiratory responses and pedal force between front and rear saddle trial during a tandem-bicycle ergometer exercise. Methods: Six Japanese healthy young males volunteered to participate in this study. Their age, height, weight, and peak oxygen uptake were  $20.2 \pm 0.4$  years,  $170.0 \pm 5.9$  cm,  $62.2 \pm 3.0$  kg and  $49.0 \pm 2.2$  ml/kg/min (mean  $\pm$  SD). All subjects signed informed consent forms prior to participation in this study. The subjects were divided into three pairs matching for peak oxygen uptake. The subjects performed one-legged exercise with tandem-bicycle ergometer four times (for both the right-leg in front (RF) and left-leg in rear saddles (LR), for both the left-leg in front (LF) and right-leg in rear saddles (RR)). Each condition was randomly selected. The exercise was done for ten minutes (Pedal rate; 60rpm, load; 2.0 kp). We measured heart rate, oxygen uptake and pedal force. Results and Discussion: Mean values of heart rate, oxygen uptake and pedal force were  $105.8 \pm 21.8$  bpm,  $15.3 \pm 4.2$  ml/kg/min and  $163.1 \pm 40.4$  N (RF),  $106.5 \pm 22.1$  bpm,  $16.0 \pm 3.3$  ml/kg/min and  $160.7 \pm 40.5$  N (RR),  $113.3 \pm 23.1$  bpm,  $18.7 \pm 5.1$  ml/kg/min and  $175.1 \pm 34.1$  N (LF),  $113.8 \pm 24.3$  bpm,  $18.4 \pm 3.7$  ml/kg/min and  $178.0 \pm 37.7$  N (LR), respectively. No significant differences were found in heart rate, oxygen uptake and pedal force between the RF and RR, LF and LR conditions. These results suggest that physiological responses and pedal force during one-legged exercise with tandem-bicycle ergometer are at comparable levels between the

front and rear saddle trial. [The Ministry of Education, Culture, Sports, Science and Technology, Grant-in-Aid for Scientific Research (24500686)]

### **CAN WE IMPROVE MORNING QUADRICEPS MAXIMAL VOLUNTARY CONTRACTION FORCE BY BRIGHT LIGHT ADMINISTERED THE DAY BEFORE, DAWN SIMULATION ON THE DAY OF TESTING OR A COMBINATION OF BOTH?**

Edwards, B.J., Hall, E.C.R., Bowden-Davies, K.A., Dugdale, M., Knight, J.C., McGuire, S., Rama, J.J., Pullinger, S.A., Ab Malik, Z., Robertson, C.A., Erskine, R.M., Burniston, J.G., Waterhouse, J.M.

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Humans are biologically weaker in the morning than the evening; heats for major sporting competitions are sometimes scheduled in the morning. Therefore, we investigated potential methods to improve morning muscle performance by either, exposing subjects to 1) morning exogenous dawn simulation on the day of testing (DS); 2) bright light administered the day before (BL), or 3) a combination of both dawn simulation and bright light conditions (BL+DS). Ten active males (mean±SD: age, 25.5±1.9 yrs; body mass, 71.0±6.7 kg; height, 1.8±0.1 m) volunteered and were familiarized before completing six sessions counterbalanced in order of administration (separated by 48 h): control morning (M, 07:30 h) and evening (E, 17:30 h) sessions followed by 3 further sessions at 07:30 h preceded by either a morning exogenous dawn simulation on the day of testing from 05:30 to 06:00 h (DS); bright light administered the day before (1 h at 07:00 h, BL), or a combination of both dawn simulation and bright light conditions (BL+DS). Each trial involved a resting phase, 5-min cycling at 150 W, then four measures of maximal voluntary contraction (MVC) with twitch-interpolation technique on an isometric ergometer. Rectal and muscle (T<sub>rec</sub> and T<sub>m</sub>) temperatures, ratings of perceived exertion (RPE), thermal comfort (TC) and perceived effort (PE) were measured at rest, following warm-up, before or after the MVC efforts. Resting values for perceived onset of mood state was measured. Data were analysed by GLM with repeated measures. T<sub>rec</sub> and T<sub>m</sub> values were higher in the evening than the other conditions (~0.5 and 0.6°C respectively; P<0.05). M values for T<sub>rec</sub> and T<sub>m</sub> were no different than the other morning conditions (P>0.05). T<sub>rec</sub> and T<sub>m</sub> values increased from rest, post warm-up and until the MVC were completed. There was no interaction between condition and time, such that the profiles increased in the same manner over time for each condition. The subjects' ratings of TC, RPE and PE was no different between conditions (P>0.05). There was a significant effect of time such that TC and RPE increased from rest to post MVC, however there was no interaction. E condition resting calm, happy and vigour 'mood' scores were higher than any other condition. All conditions showed higher isometric peak force for knee extension compared to that of a morning control condition (range of 10.5-17.8 % or 70.2-118.3 Nm<sup>-1</sup> respectively; P<0.05). However, there was no statistical difference between experimental and E condition such that all experimental conditions showed the possibility to potentially offset the daily variation in muscle strength and this has implications for athletes who are competing in the morning. The reason for this improvement however, is still unclear. Further research utilising these 'lighting' conditions but with a direct measure of sporting performance such as a self-paced cycling time-trial is warranted.

### **THE EFFECT OF PROLONGED EXERCISE ON BRAIN ACTIVITY MOOD AN EFFORT**

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**INTRODUCTION** Long duration exercise has been linked with the psychological model of Flow. Flow describes a mental state, during which a person is fully immersed in the process of an action. It is expected that the Flow experience is going along with specific changes in cortical activity, especially a transient hypofrontality which has recently been connected with an increase in cognitive performance post exercise. Nevertheless data on neuro-affective and neuro-cognitive effects during prolonged exercise are rare. **METHODS** Within this study cognitive performance as well as mental state, flow experience and brain cortical activity were assessed several times before, during and after a six hour run in eleven ultra marathon runners (six female, five male). **RESULTS** Results indicate a decrease of cortical activity (beta-activity) in the frontal cortex, whereas no changes could be obtained for global beta, nor frontal or global alpha-activity. Perceived physical relaxation and flow state increased significantly after one hour of running but decreased during the following five hours state. Perceived physical state and motivational state remained stable during the first hour of running but then decreased significantly. Cognitive performance as well as underlying neurophysiological events (recorded as event related potentials) remained stable across the six hours run. Except the fact that women reported significant higher levels of Flow no further gender effects were noticeable. **DISCUSSION** Following the theory of a transient hypofrontality, a clear and significant decrease in frontal cortex activity was noticeable. Interestingly this had no effect on cognitive performance. The fact that self reported Flow experience increased just during the first hour of running followed by a dramatic decrease let us assume that changes in cortical activity and the experience of flow are not linked as previously supposed. **CONTACT** p.wollseiffen@dshs-koeln.de

### **THE EFFECT OF MATCH-RELATED PHYSICAL EXERTION ON REACTIVE AGILITY IN RUGBY LEAGUE PLAYERS**

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**Introduction** Previous research in Rugby League has reported reductions in agility following game-specific exercise. A fundamental component of agility is decision-making as players are required to execute a quick change of direction in response to unpredictable stimuli (Serpell et al., 2010). Few studies however, have considered this decision-making stimulus. Considering that the high physiological demands of Rugby League force players to compete under high levels of physical exertion, the aim of this study was to examine the impact of an 80-minute match simulation protocol on reactive agility accounting for player's fitness level. **Methods** Twelve Rugby League players (mean ± SD, age 23 ± 3 years, height 1.8 ± 0.1m, body mass 87.7 ± 11.5 kg) participated in this study following ethical approval and informed consent. Players initially undertook measurements of anthropometry and fitness testing including an assessment of aerobic capacity (20m Multi-stage Fitness Test). During the follow-up testing session, players were asked to perform an 80-minute match simulation protocol (Sykes et al., 2013). Three trials of the repeated Reactive Agility Test (rRAT; Jordan et al., 2013) were performed at six time points throughout the simulation protocol. Reactive agility was measured as the combined total of decision-making and sprint time. **Results** Decision-making time, sprint time and total time were assessed using a two-way ANOVA with repeated measures (time point [6] x trial [3]) to assess differences over time and between trials. A significant main effect of trial on decision-making time was reported (P = 0.033). Post-hoc analysis using the Least Significant Difference (LSD) correction revealed that the time taken to complete the first trial of each rRAT was significantly higher than the time taken to complete the third trial (P = 0.027) across the six time points. Using individual

body fat percentage and fitness level as separate covariates, no significant interactions were reported. There were also no significant main effects of physical exertion on sprint time and total time. Discussion Match-related physical exertion did not have an effect on reactive agility across the 6 match periods in contrast with the results reported by Gabbett (2008). The current findings that decision-making time was higher in the first trial compared to the third trial across the 6 periods may suggest that, rather than a cumulative effect, there is only an acute effect of match-related exertion on decision-making in Rugby League. References Dunford M, Doyle A. (2011). Nutrition for Sport and Exercise, Wadsworth Cengage Learning, Boston. Gabbett T. (2008). J Strength Cond Res 22, 625-632. Jordan J, Korgaokar A, Farley R, Coons J, Caputo J. (2014) Pediatr Exerc Sci 26,168-176. Serpell B, Ford M, Young W. (2010). J Strength Cond Res, 24, 3270-3277. Sykes D, Nicholas C, Lamb K, Twist C. (2013). J Sports Sci, 31, 48-57. Contact Darry.minova@coventry.ac.uk

### THE INFLUENCE OF UNILATERAL AND BILATERAL LOAD CARRIAGE ON GAIT AND STATIC POSTURE OF YOUNG HEALTHY MALES

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Introduction Little research has been done to examine the influence of heavy load on the youth posture and gait. The purpose of this study is to examine the influence of unilateral and bilateral load carriage on gait pattern and static posture. Methods Fifteen healthy male college students (age  $20 \pm 2$  years, body mass  $60.1 \pm 8.1$  kg) were participated in the first and the second experiments. Three carrying loads, 0%, 10% and 20% of body weight, were used as three load conditions (0%BW, 10%BW, 20%BW). The participants carried loads with two-strap backpack in the first experiment and carried load with one-strap backpack over each shoulder in the second experiment. Each participant was required to keep static posture on the plate-type pressure sensor (Footscan 2D plate, RS International) during 30 seconds on each condition to measure the contact pressure and the center of pressure (COP). The static posture was recorded by a video camera with 200Hz in filming rate. Then, each participant walked ten steps at their natural cadence on the plate-type pressure sensor. One pair of plantar pressure of the fourth and the fifth steps was measured with a sampling rate of 300Hz. Results The sum of plantar pressure and the contact time during gait increased most on the 20%BW, and then on the 10%BW in the first and second experiments. The main effects of loads were statistically significant at contact time, but the main effects of bilateral difference were not. The contact pressure of static posture increased more as the loads became heavier. The main effects of bilateral difference and loads were significant at contact pressure in both the experiments. The interaction effects were also statistically significant in the second experiment. The trajectory length of COP tended to be longest on the 20%BW. Furthermore, when the participant carried load over the left shoulder, the left shoulder was higher than right one and vice versa. Discussion The experiments showed that the contact time during gait was longer as the loads increased. Our results were similar to the results of Ghori et al. (1985), Choi et al. (2007) and Ozgul et al. (2011). It was suggested that when the loads increased, it took more contact time to stabilize gait. However, the bilateral difference of the contact time was not significant even when the participant carried unilateral loads. It was suggested that the contact time was so short that unilateral loads had little influence. In contrast, the significant bilateral differences were the contact pressure and the position of shoulders in static posture. These results showed that the unilateral loads were more affected in keeping static posture than walking. References Ghori G.M.U, Luckwill R.G. (1985). European Journal of Applied Physiology and Occupational Physiology, 54, 145-150. Choi H, Hwang S, Choi H, Kim Y, Yi C. (2007). Medical Physics and Biomedical Engineering, 14(5), 2856-2859. Ozgul B, Akalan E, Kuchimov S, Uyger F, Temelli Y, Polat M. (2011). Journal of Biomechanics, 44, 7. Contact iyumiko@is.oit.ac.jp

### HEART RATE VARIABILITY DURING SLEEP IN WORLD CLASS ALPINE SKIERS: BEAT TO BEAT VARIABILITY DURING DIFFERENT STATES OF CONSCIOUSNESS

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Background/Aim: High sleep quality is essential for recovery and performance in athletes. Slow-wave sleep (SWS) is characterized by a high delta wave power of the electroencephalogram (EEG) and is an indicator of sleep quality and depth. The aim of this study was 1) to verify the relationship between cortical and the autonomic nervous system (ANS) activity by means of heart rate variability (HRV) in elite athletes, and 2) to compare HRV parameters during different states of consciousness such as wake, SWS and non-SWS. Methods: Eleven world cup level alpine skiers (age  $25.9 \pm 2.7$  y) were recruited. In each athlete, RR-intervals were monitored by ECG and delta-wave activity by 1-channel EEG during four nights' sleep as well as after awakening. Power spectral density of the EEG was calculated and the delta frequency (DF) band (1-4.5 Hz) of 30-s segments was further analyzed. A moving median filter (120 s) was applied to DF. Correlation coefficients of the RR-intervals (Poincaré plots; rRR) of consecutive 30 s were determined for the whole night. Correlations between DF and rRR time series were calculated. SWS phases were defined when DF was above 30 % of the night's maximum value for at least 10 min. For each SWS phase, a 4 min segment was placed at the segment's center and mean HRV values of all identified SWS phases were calculated. Non-SWS phases were defined for all phases with DF values below 15% of the night's maximum (comprises light sleep, REM sleep and waking). In the morning, a 4 min segment in supine position with controlled breathing was analyzed. Mean RR interval, root mean squared differences of successive RR intervals (RMSSD) and RMSSD adjusted for RR (RMSSD/RR) were calculated for the three states. HRV parameters of the three states were compared (paired Wilcoxon signed-rank tests). Results: Data of 15 nights (between 1- 4 nights per athlete) were of sufficient quality to be included in analysis. Mean correlation between DF and rRR was  $-0.49 \pm 0.2$  (range -0.3 to -0.7). In SWS RMSSD/RR was lower than in non-SWS ( $P = 0.046$ ), while a trend for longer RR intervals ( $P = 0.075$ ) was observed. No differences between parameters of SWS and wakefulness in supine position were observed. Conclusions: A close relationship between HRV and cortical activity was present in elite athletes. Contrary to previous studies in non-athletes, RMSSD/RR in SWS was reduced compared to non-SWS, possibly due to a saturation of HRV in athletes.

### EFFECTS OF GRADUATED COMPRESSION STOCKINGS ON SKIN TEMPERATURE IN RUNNING

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Introduction The effect of Graduated Compression Stockings (GCS) on skin temperature after running remains unknown. The aim of the study was to evaluate the effect of running with GCS on the variation of the skin temperature of the lower limb. Methods In this study participated 44 runners: 29 males and 15 females (age  $[28.6 (4.3)]$  years), weight  $[66.3 (14.7)]$  kg], height  $[1.69 (0.7)]$  m], weekly running  $[36.6$

(14.7) km/week]. Runners performed 3 tests. First test consisted in run 5 minutes in the shortest time possible to know their maximal aerobic speed (MAS) in order to individualize their laboratory tests. Then they carried out 2 laboratory tests (one with GCS and another without GCS) in which they ran for 30 minutes: 10 minutes at a comfortable speed to warm up and 20 minutes at 75% of their MAS. 12 regions of interest (ROI's) of the lower limb was measured using an infrared thermography camera (FLIR E60, FLIR, Belgium) in 2 different moments: 1) before running after 10 minutes of acclimatization; 2) after running. Temperature variation was compared before and after the running test. Differences between GCS test and the test without GCS in the ROI's were analyzed with a repeated-measures ANOVA ( $p < 0.05$ ). Results Wearing GCS presented a greater temperature increment than the test without GCS ( $p = 0.002$ , 95% CI [0.11 - 0.45°C]). The main differences were observed in the vastus lateralis ( $p = 0.04$ , 95% CI [0.01 - 0.52°C]), abductor ( $p = 0.04$ , 95% CI [0.01 - 0.48°C]), ankle anterior ( $p = 0.003$ , 95% CI [0.21 - 0.91°C]), tibialis anterior ( $p < 0.001$ , 95% CI [0.34 - 0.83°C]), semitendinosus ( $p = 0.04$ , 95% CI [0.01 - 0.48°C]) and gastrocnemius ( $p = 0.02$ , 95% CI [0.04 - 0.46°C]). Discussion The present study explored the effect of running with GCS on skin temperature of the lower limb before and after running. The main finding was the greater variation of skin temperature wearing GCS. On the one hand, this greater variation could be due to the insulating effect produced by the textile which reduced the effectiveness of the sweat evaporation (Sperlich et al. 2013). On the other hand, the increase in the temperature variation in the body regions that were not in contact with the garment could be explained by the greater blood perfusion generated by the compression of the GCS (Ali et al. 2010). Nevertheless, this higher variation of the skin temperature did not exceed 33°C in any ROI which is considered as a limitation of the aerobic performance (Sawka et al., 2012). In conclusion, running with GCS produced a greater variation of the skin temperature that may be explained by the textile insulation and the higher blood perfusion. References Ali A, Creasy RH, Edge JA. (2010). Eur j appl physiol, 109(6), 1017–1025. Sawka MN, Chevront SN, Kenefick RW. (2012). Exp Physiol, 97(3), 327–332. Sperlich B, Born DP, Lefter MD, Holmberg HC. (2013). Wild Env Med, 24(3), 211–220. Contact m.gil.gib@gmail.com

## Mini-Orals

### MO-SH13 Sociology/Sport management II

#### IDENTIFY FACTORS INFLUENCING THE PROCESS OF SOCIALIZATION THROUGH SPORT

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Identify Factors Influencing the Process of Socialization through Sport Abstract Research showed that participation in sport decrease antisocial behaviors and increase sociomoral behavioral in athletes (Rutten et al,2007).Van Bottenburg and Schuyt (1996) contend that sporting activity fosters the development of important virtues, such as team spirit and social responsibility (Van Bottenburg, Schuyt,1996).Coakley (1984)emphasized that sporting activity stimulates social-cognitive competences, such as role-taking ability, as athletes must constantly anticipate their opponents' actions or moves (Coakley,1984). While role-taking ability is a necessary condition for growth in moral reasoning, virtuous dispositions like self-control or perseverance could be important for the translation of moral reasoning into moral behavior (Matsuba and Walker,1998). The aim of this study was to identify factors influencing the process of socialization through sport. Method: Total 270 athletes were selected randomly as sample. Face and content – related validity of questionnaire improved by experts and reliability of questionnaire obtained  $r = 0.88$  in a pilot study. Factor analysis method was used to identify factors. LISREL software was used to determine the factor loadings. Result: The results revealed seven major factor priorities are family with factor loading 0.786, Competence with factor loading 0.739, strengthens human values 0.745, peers 0.615, and expands human communication with factor loading 0.656; efficiency and Adequacy with factor loading 0.756 as well as coaches with factor loading 0.616 are factors which play a major role in the socialization through sport. Conclusion: Socialization process can easily be achieved through participation in sports activities. It is one of the most important components of growth and one of the most fundamental aspects of the personality. In this process social values is preferred to individual values, all people are trying to achieve a common goal.Family and peers are important in socialization through sport Exercise helps everyone do their role well in the society. Coakley JJ. (1984) .Mead's theory on the development of the self: implications for organized youth sport programs. Paper presented at the Olympic Scientific Congress, Eugene, OR. Matsuba MK, Walker LJ .(1998). Moral reasoning in the context of ego functioning. Merrill-Palmer Q 44:464–483. Rutten ,E. A, Stams .G. J. J. M, Biesta. G. J. J, Dirks .E, Hoeksma. J. B.(2007).The Contribution of Organized Youth Sport to Antisocial and Prosocial Behavior in Adolescent Athletes. J Youth Adolescence (2007) 36:255–264.

#### SPORT VS. SCHOOL: CONCILIATION STRATEGIES OF YOUNG ATHLETES BENEFIT FROM ATHLETE SCHOLARSHIP PROGRAM IN BRAZIL

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The formation of high-level athletes competes with the student life of young people around the world. With the completion of major sporting events in Brazil, the condition maintenance programs of athletes became part of the national political agenda, including young students that, with his family, establish conciliation strategies between the times of sports training and education. In this paper, we analyze the group benefited by the Student Athlete Scholarship Program of the Ministry of Sport growth acceleration program, which matches young 245 athletes, between 14 and 20 years old, who work in several Olympic and Paralympic sports. The sample submitted to the questionnaire was comprised of 165 athletes, the data recorded in the SPSS for Windows, and treated from a statistical analysis descriptive and multivariate analysis. The next step was interviews with 20 young athletes who allowed deepen unanswered questions by quantitative data. We use the thematic content analysis for the treatment of textualities written and spoken, that were organized in the software WebQda. Of the twenty respondents, thirteen assumed the difficulty of reconciliation, but not its impossibility. One athlete declares it is impossible to reconcile because of the tiredness of the routine training/school. About the career in the sport the goal is to participate in the world championship of each modality and of the Olympic Games and, as they reach sports success, the greater the chances of shift away from education. The twenty respondents intend to follow through with the studies, because they understand that the sports life is short and the school provides the credentials required by the labour market. We note that the criteria for obtaining results for conquer the scholarship can cause a reverse effect to the goal of the program (keep the young in school), because the athlete leaves the background studies to maintain their results and, and by consequence, the scholarship. Another problem is the lack of interaction

between school systems and Brazilian sports system, leaving the young athlete with the responsibility of reconciling its formation. CHRISTENSEN, Mette Krogh; SØRENSEN, Jan Kahr, "Sport or school? European Physical Education Review, v. 15, n. 1, p. 115-137, nov. 2009. CORROCHANO, M. C., & NAKANO, M. (2002). Vol. 7, pp. 95-122. Brasília. METSA-TOKILA, Timo. European Physical Education Review, v. 8, n. 3, p. 196-206, 2002. costaesilva@gmail.com

### SELECTION IN NORWEGIAN MALE SOCCER: FROM THE U-15 NATIONAL TEAM TO THE A-NATIONAL TEAM

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**Introduction:** The Norwegian Soccer Association has the oldest, most extensive and most systematically selection structure to be found within Norwegian sports. Those that are considered to be the most talented players are selected out in a series of steps, including zone, district, pre-youth national teams and national team. However, selecting at young age may hold the problem of ignoring potentially talented and perhaps late maturing players. **Purpose:** Examine 1) to what extent male soccer players selected for the U-15 national team experienced the event of playing for the A-national team; 2) if being selected for the U-15 national team influences career length. **Methods:** Altogether 563 male, Norwegian soccer players, selected for the U-15 national team in the years 1982-2003 and the A-national team in the years 1998-2011, were included in this study. Career length was defined as the number of appearances at the A-national team and was evaluated by a linear regression model including only those who had appeared at the A-national team. Cox regression analysis, including those players who had been selected to the U-15 national team, was applied to evaluate time to event. Time to event was defined as time elapsed from the first U-15 national appearance to the first A-national appearance. **Results:** Of the players that had been selected for the U-15 national team, 7.8% did experience the event. For time to event, Cox regression showed that the number of appearances at the U-15 national team as well as playing for several pre-youth national teams, were not as important as being selected to the U-21 national team ( $BEXP = 35.7, p < 0.001$ ). Of the players that actually appeared at the A-national team, 75% had formerly participated at the U-21 national team. Of these, 75% were not selected to the U-15 national team when they were at that age. Previously being selected to the U-21 national team significantly predicted the number of A-national team appearances ( $BUNSTD = 13.3, p = 0.006$ ); being a former U-15 national player was not significant ( $BUNSTD = -4.7, p = 0.34$ ). **Conclusion:** Our data indicate a weak relationship between selection to the U-15 national team and later selection to the A-national team, as well as career length, while the association between selection to the U-21 national team and future A-national team appearances appear to be stronger. This may indicate an inaccuracy in selecting early in the youth when the goal is to pick out athletes for successful performance at adulthood. Further analyses and studies should investigate the potential effect of time of birth in the selection year, as this may confound the selection process.

### THE IMPACT OF STUDENTS RECREATION CENTER ON SOCIAL BELONGING AND RETENTION

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**THE IMPACT OF STUDENTS RECREATION CENTER ON SOCIAL BELONGING AND RETENTION** **Introduction** The opportunity to socialize with other ones can be considered as a vivid and inherent characteristic in recreational activities which is more obvious in intramural activities. These intramural programs prepare suitable and important conditions for students to socialize. These relationships can lead to significant improvement of social skills and belonging sense and coordination with university, it can even rise the rate of retention among the students who participate in these activities continuously [3]. The purpose of this study was to assess the relation of student recreation center use on feelings of social belongings and retention at 8th district of Islamic Azad University. **Methods** Descriptive and inferential or Pearson correlation statistics were used to analyze research findings. **Results** Findings showed that students who used student recreation centers enhanced their sense of belonging to the university, however male students preferred high interaction with peers. The correlation results indicated that the number of times a student works out at the student recreation center influences the way in which they interact with new people, relates to his or her perceived self-confidence and leadership abilities, and improved their perceived ability to manage time. **Discussion** In this study it was found that by increasing the number of students trained in these centers get more confident. There are significant, and previous research has often been limited to a specific group of students, but the results of the present studies [1, 2, and 5] found that as many students in recreational activities or sports participate as a way to increase social interaction by interaction with the students is to be consistent. Also research [6, 4], which showed that the recreational sports community is a place where students can communicate with their peers to provide, without regard to whether to participate or not and also, increasing conscious leadership ability, the students stay at recreational areas and other areas interested. Improving Time Management among students, as another important factor, this paved the way for a stay at the University and has been followed by improvements in education. **References** [1] Artlinger, L., Clapham, L., Hunt, C., Meigs, M., Milord, N., Sampson, B., & Forrester, S.A.(2006). *NASPA Journal*, 43(1), 69-86. [2] Britni C. Henderson( 2010). The impact of students recreation centers on social belonging and retention. Master of arts dissertation, Texas Tec University. [3] Frauman, E. (2005). *Recreational Sports Journal*, 29(2), 156-165. [4] Haines, D.J. & Fortman TL. 2008. *Recreational Sports Journal*, 32(1), 40-42 [5] Hall, D. (2006). *Recreational Sports Journal*, 30, 40-45. [6] Huesman, R.L., Brown, A.K. Lee, G. Kellogg, J.P. and Radcliffe, P.M. (2008). *Modelling Student Academic Success: Does Usage of Recreation Sports Facilities Make a Difference?* Unpublished manuscript, university of Minnesota, Twin cities. E-mail :dr\_alizarei@yahoo.com

### INSIGHTS FROM THE "LLP FACILITATING HIGHER EDUCATION FOR ATHLETES – WINNER EDUCATION MODEL" PROJECT: PRELIMINARY FINDINGS ON ITALIAN STUDENT-ATHLETES' PERCEPTIONS ON DUAL CAREER OUTCOMES AND SERVICES

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**Introduction** Dual career (i.e., the combination of sport and education) has become a crucial issue in the European Commission (EC) strategies for sport (EC, 2012). In this framework, the LLP WINNER EDUCATION MODEL intends to structure an appropriate education model for dual career students (<http://www.winner-project.eu/>). Therefore, the aim of this study was to investigate student-athletes' opinions regarding: i) their sport and academic career outcomes; and ii) available dual career services and possible implementations. **Methods** Using the focus group method (Kitzinger, 1994), a 36-item semi-structured questionnaire was created during a project meeting. The English version of the instrument was back translated (Su and Parham, 2002) to achieve a valid Italian version. Participants were required

to respond on-line to closed-ended items (5-point Likert-type agreement scale) and to provide additional open comments. Descriptive statistics was used to analyse collected responses. Results Thirty-four respondents (gender: 50% male, 50% female; age: 24.6±3.5yrs; type of sport: 71% individual, 29% team; competition level: 56% national, 44% international) declared to be satisfied with their educational path (3.9±1.0pts), to be able to meet the academic requirements (3.4±1.2pts), perceiving that the university provides them a good education (3.0±1.0pts) for their future professional opportunities (3.3±0.9pts). Nevertheless, the dual career was perceived highly demanding (3.6±1.0 pts) in absence of academic (2.5±1.4pts) and sport (2.0±1.3pts) policies. However, student-athletes were able to manage both academic (3.5±1.0pts) and sport (3.9±0.8pts) careers. Furthermore, the sport staff was perceived more sensible (3.4±1.3pts) and available for a flexible path (2.7±1.4pts) compared to teachers (2.1±1.2pts and 1.7±1.0pts, respectively), whereas family and peers were considered highly supportive (4.2±1.0pts). Finally, the need for a flexible academic path (i.e., class attendance and exam schedule), the recognition of the student-athlete status, e-learning provisions, an effective dialogue with teachers, and a higher cooperation between sport and academic organizations emerged. Discussion Findings confirm the importance to guarantee proper services to Italian elite student-athletes. Further cross-national comparisons are needed to structure an appropriate dual career education model in Europe. References European Commission (2012). EU Guidelines on Dual Careers of Athletes. Kitzinger J (1994). *Sociol Health Ill*, 16: 103-121. Su CT, Parham LD (2002). *Am J Occup Ther* 56(5), 581-585.

## A STUDY ON THE PREVENTION POLICY ESTABLISHMENT FOR SCHOOL SAFETY INCIDENTS IN KOREA

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Introduction: School safety incidents, occurring during educational activities, are any accidents that damage lives or the bodies of students, faculty and staff members, or educational activity participants, and diseases of those directly caused by works belonging to the management and supervision of the principal such as school lunches and etc. The purpose of this study is to establish the concept of the school safety incident and also its prevention policy by statistically analyzing the existing data of school safety incidents (Lee, 2011). Methods: Domestic and international literature, including various reports and academic research papers, related to school safety incidents were surveyed to analyze the current status of existing school safety incidents. The current status such as frequency of occurrence and major causal analysis of school safety incidents was analyzed by applying the cross-analysis out of statistical analysis techniques on 105,323 cases of school safety incidents of FY2013. In-depth interview was carried out. First, a qualitative analysis of the various conditions and circumstances was performed on experienced people and witnesses of school safety incidents. Second, in-depth interview was performed three times on three security professionals. The survey was conducted by FGI (Focus Group Interview). The ideas on the prevention policy were brought out by expert meeting. Results: School accidents were occurred most frequently in class for kindergarten (44.4%), in physical education class and lunch time (47.8%) for elementary school, in physical education class for middle school (34.8%) and high school (31.1%). School safety incidents were most frequently occurred at the class rooms for kindergarten (49.7%) and at the playgrounds for elementary school (36.5%), middle school (46.1%), and high school (48.0%). While the most injured part of students was head for the kindergarten (43.3%) and elementary school (36.5%), it was foot for middle school (21.6%) and high school (29.1%). Discussion: In this study, the concept of school safety incidents was classified into life safety, school violence, road safety, disaster safety. Prevention policy proposals for school safety incidents consist of (i) execution of the project on improved School Safety Awareness: reestablishment of the scope and content of school safety, construction of School Safety Information system, safety management of school bus in school education, operational management, and training activities., (ii) improvement of School Safety Physical Environment: safety management of school facilities, access control of outsiders, operations management of school CCTV's, improvement of environmental management for around schools, improvement of school violence-related systems, (iii) reestablishment of School Safety organization • system: reestablishment of management organization for School campus safety, installation and management of Experience comprehensive school safety, stable financing for school safety, legislation of comprehensive school safety law.

## Mini-Orals

### MO-SH08 Sociology/Sport management I

#### SPORT TOURISM IN KOSOVO – THE IMPACT OF HIKING

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Sport Tourism is one important and growing part of the total Tourism-industry around the world. This study concentrates on Sport Tourism in Kosovo, Studying Hiking as a specific phenomenon within the field of Sport Tourism. I analyze the Sport Tourism sector from a macro-, meso-, and micro level and my study are among the first studies within this field in Kosovo. The aim of this study is to analyze and understand the possibilities for sport tourism in Kosovo and I use hiking as a case to explore and explain this the entire research is based on the empirical research and has provided data from locally Kosovo. Since there was no empirical data made there, it was very tough to find and based in very little research that was done previously in Kosovo. In Kosovo until now there are no significant academic researches made regarding tourism and sport Tourism. There are number of institutions which provide information regarding the tourism, and Sport Tourism, but the major problem remain on the accuracy of this data's, since they are coming from different sources and very often influenced from daily politics aspect. Since the policy of government has been focus in other direction of investment I do believe that my research will increase the awareness to Kosovo institutions, that maybe in future the investment will change direction in Sport Tourism and Hiking. This study tends to explore this phenomenon and to try to create a better knowledge within this area related to Kosovo. And because of this I have used the exploratory research approach. Hopefully Sport Tourism in nearest future can have a good impact to increase the Kosovo economy. The aim of this research is to analyze sport tourism and Hiking in Kosovo. This thesis uses qualitative research techniques, mainly in-depth interview. In addition, the reflective practice technique was used because the author of the thesis has been involved in implementing the Hiking guides around Kosovo.

## INVESTIGATION THE BARRIERS REVENUE FROM SPORTS TOURISTS

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Do not insert authors here Introduction Tourism is a commercial activity. Major corporations such as airlines and major hotel chains have an interest in fostering niche tourism markets such as sport tourism. Sporting events as a major tourist attraction and development capabilities in research have been underlined. Features and capabilities as a critical component of the tourist destinations in the business of hosting sporting events emphasize with the researchers Methods The method of this study was descriptive survey with the practical purpose. The statistical population was include all persons who had at least one book or two scientific papers in areas related to employment and tourism and the administrative experts in the field of employment and tourism, with at least a bachelor's degree, who are at least 10 years of experience. Samples were selected through stratified random sampling. The measurement tool in this research was researcher- designed questioner. The final questionnaire's face validity was approved by experts. To determine the content validity were used exploratory and confirmatory factor analysis. Cronbach s Alfa coefficient was calculated 0/90. Structural equation models (SEM) were investigated to access variables observed effects on the latent variables and confirm the conceptual model. Results Friedman test showed significant differences between the various obstacles revenue( $X^2= 652.616$ ,  $p= 0.001$ ). The results showed that the various obstacles, the low level of tour leader in In implementing Tour was First rank, The low number of major events was second rank and Lack of proper marketing in attracting tourists with high incomes was third rank(mean rank 1= 7.28, mean rank 2=6.62& mean rank 3= 6.17) Discussion The tour leader must be increase the information about manage behaviours with tourists. Sport is both a community activity and a major part of the entertainment industry. At the local level, it is a social activity run primarily by volunteers, and is very much not-for-profit. At its highest levels of performance, it is a multi-million dollar industry. Sporting events as a major tourist attraction and development capabilities in research have been underlined (Solberg, Preuss, 2007; Icoz et al., 2010). Features and capabilities as a critical component of the tourist destinations in the business of hosting sporting events emphasize with the researchers (Emery, 2010). References Emery, P.(2010) Past, present, future major sport event management practice: the Practitioner perspective, Sport management review .13,158-170. Journal homepage:www.elsevier.com/locate/smgames/vol.12.pp.5-23. Icoz,O ,Gunlu, E & Oter, Z. (2010) 'Sport tourism destinations as brand and factors affecting destination choices of soccer teams'. 5th International congress on Business, economic and Management. Solberg, H & Preuss, H. (2007) Major sport events and long-term tourism impacts. Journal of sport Management 21, 213-234. Email: delfan26@yahoo.com

## ORAL PRESENTATION

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We carry out a documentary research to determinate key aspects for this study e.g. Hublot, Nike, Adidas, Falcao, Cristiano Ronaldo, James Rodriguez. Situations concerning show business, marketing and big money as pressure to the sport people result in a kind of harassment in sport. The terminological methods and the analysis done, allowed the elaboration of a conceptual map (Plested, M.C., Giraldo, B.S., 2001) and showed general behavior concepts taken from specific cases, which will be discussed. It's necessary to deep into the analytical reflections to take socio-educational measures as analysis against these marketing behaviors e.g. "The private franchise ownerships" as in USA sport. We propose outreach activities at national and international committees to search for a new agreement about this social reality. A qualitative methodology to analyze sociologically statements regarding their origins, and also a conceptual analysis to different contexts was applied. A qualitative methodology concerned to terminologically analyze the statements (Budín, 1998) under the concept of 'representative virtual psychological space of each implicated' (Sánchez Medina, G. 1987) in conjunction to the world image permitted to confirm some business and marketing, as a social case study "Professional sports may be one of the most misunderstood occupations in the world. The public sees the mansions, the bling, and the fancy cars. What it doesn't feel is the insecurity of a profession that averages just two and a half to four seasons before someone younger, faster or stronger comes along. It doesn't see the scam artists who suck away salaries and it doesn't see the egotism and sense of entitlement that can lead a ... to believe that the rules that govern society do not apply to them" as said in Scandals of the decade. It is necessary to change some commercial and marketing parameters taking into account the cultural, social environments and also the staff of each of those sportspersons. After tracing the life details of sportspersons, it was systematically found that the specific staff was part of the scene, working under his or her instructions. Some of the specific teaching parameters in sport need to face up some universals to improve or understand the situation. We concluded that in some cases sport marketing is conceptualized through actions which actually place sport people as market objects. Unfortunately, it seems that this is a fixed parameter of those who call themselves 'members of a civilized sport culture'. We propose some cultural and pedagogical sportive ways to minimize it. References: <http://baselworld.hublot.com/>; Beckham's passion; Budín, G. (1998): *Wissenschaftskommunikation im Spannungsfeld. Zwischen Globalisierung, Technisierung u. kultureller Diversität*. Plested, M. C., Giraldo, B. S. (2001) *The Ideal Subject-field Terminology Commission In: 6th Annual Congress of the European College of Sport Germany* Sanchez, G. (1987) *Tiempo, espacio y psicoanálisis*, Bogotá, Colombia Wong, Glenn (2010) *Essentials of Sport Law*

## THE IMPACT OF DEVELOPING SUSTAINABLE FACILITIES ON LOCAL SPORTS PARTICIPATION: THE ITALIAN CASE

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The aim of this paper is to analyze how recent initiatives to build or develop sustainable sports facilities have influenced local sports participation in Italy. Past statistical analyses show that Italian infrastructures are frequently old and impracticable, and that there is a significant difference between northern and southern regions (in terms of both number and quality of infrastructures). Furthermore, previous studies have highlighted a lack of variety in the sports facility supply. This has led to low levels of sports participation for several reasons: for example, high prices, inflexible opening times and long distance from the place of residence. Against this background, Italian institutions recently adopted several measures to enhance the sustainability of local sports facilities. Most of these measures are improvements of preexisting structures, such as removal of architectural barriers or increases in efficiency. In other cases, governments have even built new sports facilities for free sports activity (for example, outdoor gym or cycle routes). By concentrating on a dozen of specific measures, the paper starts from analyzing the differences between renovating existing facilities and building new infrastructures. The paper will then focus on the effects of these interventions with respect to: (1) the number of people who practice sports activities; (2) the categories of people who practice sports activities (for example, on the basis of age, type of job, revenue, etc.); (3) variation in the supply of sports facilities.



**BRAND CULTIVATION AND DEVELOPMENT STRATEGIES IN THE POPULARIZATION OF CHINA'S TRADITIONAL TAI CHI**

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**Introduction** The thesis analyzes the orientation of cultural brand of Tai Chi from its product dimension, competition dimension, audience dimension and strategic level through application of the research methodology of documentation, expert interviews and synthetic analysis and on the basis of discussion of the concept, significance and entitlement of Tai Chi cultural brand. Meanwhile, the thesis advocates enhancement of Tai Chi cultural industry via all-in fitness and diversified security system and proposes references to its cultivation and development strategies. The research findings aim to enrich the content and cultural value of Tai Chi theoretical system and eventually to serve the popularization of China's traditional culture as well as the construction of sports strength. **Methods** The analyses are based on documentation, expert interviews, and logicalization. **Results** Tai Chi, the general term for Tai Chi techniques and relevant cultural theories, is the precious Chinese cultural heritage and the perfect integration of Tai Chi boxing and traditional culture. It is endowed with the essential spirit and value orientation of Chinese traditional culture, which is characterized with the Chinese ancient philosophical outlook of integrity of Man and Nature and the unity of Body and Mind, as well as the combination of body care and body fitness under influence of specific Chinese outlook on life and exercise. As a result, Chinese Tai Chi exerts appeal, assimilation and integration on a variety of sports cultures throughout the world. It is of great significance to innovate, enhance and popularize the cultural brand of Tai Chi for the purpose of global cultural exchanges of Tai Chi. **Discussion** The thesis analyzes the orientation of cultural brand of Tai Chi from its product dimension, competition dimension, audience dimension and strategic level, advocates enhancement of Tai Chi cultural industry via all-in fitness and diversified security system and proposes references to its cultivation and development strategies. The research findings aim to enrich the content and cultural value of Tai Chi theoretical system and eventually to serve the popularization of China's traditional culture as well as the construction of sports strength. It is anticipated that more institutes devoted to Tai Chi popularization will step on an industrialized and globalized path to make further progress in developing this cultural brand by resorting to scientific, innovative and inclusive development. **References** [1] LUO Wei-min, GUO Yu-cheng. Study on Tai Chi Cultural Brand Popularization [J]. *Sports Culture Guide*, 2012, (5):125-128. [2] DU Shu-shu. Study on Martial Arts During Qin & Jin Dynasties [J]. *Sports Science*, 2013, 33(4) : 70-90. [3] ZHANG Yu, LIANG Shu-fen, WANG Qiu-li. Investigation and Analysis of Tai Chi Popularization in Jiaozuo City, Henan Province [J]. *Shaolin and Taiji*, 2009 (1: 52-54. [4] LIN Xiang-yun. Cultural Reflection on Development of Modern Martial Arts[J]. *Journal of Nanjing Sports Institute*, 2013,27(2): 22-24.

**Mini-Orals****MO-PM26 Rehabilitation and Physiotherapy: Orthopedic rehabilitation****INTRA- AND INTER-RATER RELIABILITY OF STANDING HIP FLEXION STRENGTH AND SUPINE LUMBO-PELVIC CONTROL IN PATIENTS WITH LONGSTANDING HIP AND GROIN PAIN.**

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**Background:** Longstanding hip groin pain (LHGP) is a common problem among athletes. Reduced isometric hip flexion strength in a sitting position has been observed in patients with LHGP. However, the sitting test position does not resemble any functional activity. Poor lumbo-pelvic control (LPC) has been suggested to contribute to the development of LHGP. Double leg lowering test (DLLT), i.e., a person's ability to stabilize the pelvis when the legs are actively lowered from 90° hip flexion in a supine position, has shown to be a valid test for LPC. Limitations of this test are that it provides an indirect measurement of pelvic movement and has limited accuracy. **Aim:** To assess inter- and intra-rater reliability of a novel test of standing isometric hip flexion and a modified double leg lowering test for assessing LPC. **Method:** Isometric hip flexion (N) was tested in a standing, and thus more functional position, using a fixated hand held dynamometer (Standing Isometric Hip Flexion, SIHF). An iPod-based tilt sensor attached to the pelvis was used to provide a direct measure of pelvic tilt and a digital inclinometer attached to the thigh was used to give a more accurate degree of maximal active leg extension during the DLLT (modified DLLT, mDLLT). A starting position of 70° hip flexion was chosen to avoid the posterior pelvic tilt effect due to any hamstring tightness. The maximal hip extension (°) was measured when the pelvis reached 10° anterior tilt. The SIHF and the mDLLT were tested by two assessors independently on two separate occasions, three to seven days apart. Ten persons with LHGP and ten age- and gender-matched healthy controls participated and were analyzed as one group and as two separate groups. The intra-class correlation coefficient (ICC) was calculated for relative reliability, and the standard error of measurement in per cent (SEM %) and the minimal detectable change in per cent (MDC %) for absolute reliability. **Results:** Inter- and intra-rater reliability, for both assessors and both occasions, showed ICC values of 0.923-0.964, SEM% of 7.5-10.7% and MDC% of 20.8-29.7% for the SIHF and ICC values of 0.780-0.946, SEM% of 6.8-15.7%, and MDC% of 23.9-44.1% for the mDLLT. **Conclusions:** The ICC and SEM% indicate that the SIHF has good inter- and intra-rater reliability at the group level for patients with LHGP and healthy controls. A change of 20-30% is required to be considered a true change for an individual. The mDLLT showed acceptable inter- and intra-rater reliability at the group level for both groups. A change of 24-44% is required to be considered a true change for an individual. These tests may be used in further studies to assess hip flexion strength and LPC in patients with LHGP.

**RETURN TO PLAY AFTER ACHILLES TENDON RUPTURE IN ELITE SOCCER PLAYER: A CASE REPORT**

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**Introduction** Rehabilitation after Achilles tendon rupture is well documented in the literature, however there is lack of studies on the return to play (RTP) issue in soccer (Bizzini et al. 2014). The aim of this case report is to describe the RTP after Achilles tendon surgery. **Methods** A 39-years-old elite (Serie-A) soccer player (height 178 cm, weight 75 kg) suffered of Achilles tendon rupture during competition. After surgery, a functional rehabilitation approach was adopted and after 15 weeks, the RTP phase started. Strength was maintained as in previous phases and specific on-field activities gradually introduced. Isokinetic test (Cybex Norm), ability to perform single heel-raises (5x25

bouts) (Saxena et al. 2011) and training loads (TLs) were considered as criteria to RTP. TLs were collected during field activity with Global positioning system (GPS). Total, moderate and high intensity running distances (TD, MIR, HIR), heart rate monitoring (HR) and training duration (min) considered as outcomes. Mean TLs for RTP and for every week were collected and standardized mean differences (ES) calculated to compare TLs to pre-injury values. Results The lay-off time was lower compared to previous study (119 vs. 161 days) (Gajhede-Knudsen et al. 2013). The injured vs. un-injured side showed lower concentric peak torques at 15, 30, 60°/s after 6 and 9 months (-21, -24, -19% and -23, -9, -8%). The single heel-raises ability was reached at week 23. The TLs between average RTP and pre-injury, were similar for HIR (ES 0.1), lower for HR (ES -0.3) and min (ES -0.9), higher for TD (ES 0.6) and MIR (ES 1.9). TD/min was found higher in RTP vs. Matches (ES 1.7). During weeks 16-18, the TD, HIR, HR, min showed lower and MIR higher values vs. pre-injury. During weeks 19-21, TD, HIR, HR, min showed higher and MIR lower values vs. pre-injury. In week 22-25 all indicators were lower except HIR (higher) vs. pre-injury. Discussion The present case report suggested the use of a multifactorial approach in RTP. Strength and single heel-raises ability are criteria to RTP. The on-field activities should simulate the sport patterns and TLs should be monitored. The case presented showed that the ability to cope with the demands coming from the field should be considered another important criteria to RTP. References Bizzini, M. and H. J. Silvers (2014). ' J Sports Sci 32: 1209-1216. Gajhede-Knudsen, M., J. Ekstrand, H. Magnusson and N. Maffulli (2013). ' Br J Sports Med 47: 763-768. Saxena, A., B. Ewen and N. Maffulli (2011). ' J Foot Ankle Surg 50: 37-40. Contact maurizio.fanchini@gmail.com

## LOWER LIMB MUSCLE WEAKNESS IN PATIENTS WITH SYMPTOMATIC HIP OSTEOARTHRITIS

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**Introduction** Lower limb muscle weakness may result in a loss of independence in activities of daily living in the elderly (Rantanen et al., 2002). Patients suffering from hip osteoarthritis (OA) and concomitant hip pain may experience muscle weakness in the involved limb and thus the aim of this study was to investigate the deficits in maximal and explosive strength for different lower limb muscles in patients with symptomatic hip OA. **Methods** Twenty patients (65±5 yrs, 174±8 cm, 77±14 kg, 9 women) scheduled for unilateral total hip arthroplasty due to primary hip OA were tested. Hip abduction and adduction as well as hip, knee and ankle flexion and extension maximum voluntary contraction (MVC) strength and rate of force development (RFD50; as the rate of force developed 50 ms after contraction onset) were evaluated in isometric conditions for both the involved and the uninvolved limb. Lower limb muscle mass was estimated using bioimpedance analysis. Data between the involved and uninvolved limbs were compared using paired t-tests ( $\alpha = 0.05$ ). **Results** Compared to the uninvolved limb, MVC strength of the involved limb was significantly lower for hip flexion (-16%), hip extension (-13%), hip abduction (-9%) and knee extension (-11%). RFD50 was significantly lower for hip flexion (-32%), knee flexion (-27%) and knee extension (-24%). MVC strength and RFD50 for ankle flexion and extension did not differ significantly between the involved and uninvolved limb. Lower limb muscle mass was lower in the involved limb (-6%). **Discussion** Patients with symptomatic hip OA displayed considerable weakness for different hip and knee muscle groups, while no ankle muscle weakness was detected. Muscle weakness may partly be explained by the lower muscle mass, but interestingly, MVC strength and RFD50 deficits did not always correspond. For example, knee flexion MVC strength was not affected by OA while RFD50 was considerably impaired (-27%), suggesting that the neural drive to the muscles crossing the knee joint may also be affected by hip OA (Aagaard et al., 2002). The observed unilateral hip and knee muscle weakness may put patients with hip OA at high risk of becoming dependent in activities of daily living. These results emphasize the importance of preventive strength training for hip OA patients, predominantly for muscles crossing the hip and knee joints. **References** Aagaard P, Simonsen EB, Andersen JL, Magnusson P, Dyhre-Poulsen P. (2002). *J Appl Physiol*, 93, 1318-1326. Rantanen T, Avlund K, Suominen H, Schroll M, Frändin K, Pertti E. (2002). *Aging Clin Exp Res*, 14, 10-15. Contact frbe@kws.ch www.lifelongjoints.eu

## EFFECT OF LOW-INTENSITY PULSED ULTRASOUND ON SKELETAL MUSCLE CROSS-SECTIONAL AREA AFTER CARDIO-TOXIN-INDUCED DAMAGE IN A MOUSE MODEL

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**INTRODUCTION** Low-intensity pulsed ultrasound (LIPUS) is a treatment used to promote wound healing. Although several studies have reported the effects of LIPUS on bone, tendon, and ligament injuries, little is known about its effects on skeletal muscle injury (Rantanen et al., 1999, Nagata et al., 2013). Since collagen content in skeletal muscle is lower than in bone and ligaments, less ultrasound energy is absorbed by skeletal muscle. We previously studied the effects of LIPUS with high energy on skeletal muscle regeneration in a mouse model at 7 days after injury and found no significant difference in mean cross-sectional area (CSA) of skeletal muscle. We hypothesize that a significant difference would be observed with muscle fibers that are more mature. **METHODS** Female ICR mice (12-week-old) were divided into muscle injury (non-US, N=20) and LIPUS exposure (US, N=22) groups. To induce muscle injury, a cardiotoxin was injected into the left tibialis anterior (TA) muscle. LIPUS was initiated 2 hours after injury to the left TA muscle and applied once daily thereafter until 6 days after injury. LIPUS was performed 10 min/day, at a frequency of 3 MHz, intensity of 0.5 W/cm<sup>2</sup>, and 50% duty cycle. The non-US group received sham LIPUS. TA muscles were excised 7 and 14 days after injury, frozen sections were prepared and reacted with anti-desmin antibody, and CSA was measured. Sections prepared 14 days after injury were reacted with anti-embryo-type myosin heavy chain (MHCemb). Results were analyzed using the unpaired t-test or chi-square test, with statistical significance set at p<0.05. **RESULTS** MHCemb-positive cells were not detected at 14 days after injury in either group. No significant group-dependent differences in mean CSA were observed at both 7 and 14 days after injury (7D, 674.9±149.2 μm<sup>2</sup> and 789.5±185.2 μm<sup>2</sup>; 14D, 1194.0±248.6 μm<sup>2</sup> and 1281.4±283.8 μm<sup>2</sup> in the non-US and US groups, respectively). However, the CSA distribution revealed a significantly higher number of myofibers with CSA>1000 μm<sup>2</sup> in the US group relative to that in the non-US group at both 7 and 14 days after injury (p<0.05). **DISCUSSION** The number of larger myofibers was significantly higher in the US group than in the non-US group at both 7 and 14 days after injury. However, even when skeletal muscle fibers were mature, no significant difference in mean CSA between the non-US and US groups was observed. Under condition in the present study, these results suggest that LIPUS likely does not promote skeletal muscle regeneration. **REFERENCES** Rantanen J, et al. (1999). *Am J Sports Med* 27, 54-59. Nagata K, et al. (2013). *Ann Biomed Eng* 41, 1095-1105. **CONTACT** 0539saku12@gmail.com

**ERROR-REDUCED OBJECT CONTROL SKILLS TRAINING: FROM RESEARCH TO PRACTICE**

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**Introduction** Children with intellectual disability (ID) display proficiency deficits in object control skills (Westendorp et al. 2011), which should be ameliorated by training. Recent research showed that reducing errors during practice improved the object control skill of throwing in children with ID (Capio et al. 2013). This paper presents how such research finding was evolved into clinically viable training programs that practitioners implement, pushing evidence-based practice. **Methods** Using a mixed-methods design, error-reduced learning was applied in a clinic-situated object control skills training program for children with ID. First, a focus-group discussion (FGD) with 5 physiotherapists of children with ID explored current approaches in movement skills training. Second, 12 children with ID (mean age = 8.5±.79 years) were allocated into one of two groups: training or waiting-control. The training group practiced 5 object control skills (strike, dribble, throw, catch, kick) over 8 weekly sessions. In each session, task difficulty was manipulated to suppress practice errors. The control group had a waiting period of 8 weeks, and received training after the post-test. Object control skill components of the Test of Gross Motor Development-2 (TGMD-2; Ulrich, 2000) were used for pre- and post-test. Third, a process evaluation examined physiotherapists' clinical notes during the program. **Results** The FGD showed that therapists typically train children with ID using graded verbal instructions and physical demonstrations. In part two of the study, non-parametric tests comparing TGMD-2 scores of training and control groups showed: (1) no group differences at pre-test in overall object control and individual skill components (all  $p > .05$ ) and (2) the training group scored significantly higher than the control group at post-test in overall object control ( $p = .002$ ) and in 5/6 skill components ( $p = .026-.002$ ). Finally, the process evaluation showed that to apply error-reduced approach, therapists used (1) small group training, (2) continuous assessment and (3) individualised progression. **Discussion** This study brings evidence from experimental research to clinical practice of physiotherapists. Analysis of multiple data sources shows how error-reduced learning may be implemented in a clinical setting, resulting in improved object control skills of children with ID. Moreover, process evaluation has identified guiding principles to support practitioners in implementing the error-reduced approach in training movement skills of children with disability. Further research is warranted to examine related outcomes such as functional independence and play patterns. **References** Capio CM, et al. (2013). *J Intellect Disabil Res*, 57(4), 295-305. Westendorp M, et al. (2011). *Res Dev Disabil*, 32(3), 1147-53. Ulrich D. (2000). Texas: Pro-Ed.

**PREDICTORS OF ONSET OF MOBILITY DIFFICULTY IN AMBULATORY PATIENTS UNDERGOING MAINTENANCE HEMODIALYSIS**

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**INTRODUCTION** Difficulty in activities of daily living is more likely to contribute to decreased habitual physical activity. Recent cross-sectional studies have demonstrated that decreased physical activity is independently associated with adverse clinical events and mortality in patients undergoing hemodialysis (HD) (O'Hare AM, et al., 2003, Matsuzawa R, et al., 2012). However, determinants of difficulty in activities in HD patients are unknown. The present study aimed to identify predictors associated with onset of mobility difficulty in ambulatory HD patients. **METHODS** This prospective and longitudinal study followed Japanese outpatients undergoing maintenance hemodialysis three times a week at the Hemodialysis Center from October 2006 to December 2014 for a 12-month period. Patients who had reported difficulty in walking at baseline, and were hospitalized during the study period due to adverse clinical events were excluded. Age, sex, body mass index, hemodialysis duration, primary cause of end-stage renal disease, blood hemoglobin, and serum albumin concentration were obtained from clinical records. The presence of comorbidities (i.e., diabetes mellitus, cardiac disease, cerebrovascular disease, and orthopedic abnormality) were also assessed based on clinical records at baseline. Moreover, leg strength and functional reach were measured to assess motor function at baseline. Patients were asked to identify whether they had difficulty in walking 1 km based on a 5-point Likert scale (inability, severe difficulty, moderate difficulty, mild difficulty, and ease) both at baseline and endpoint, and diagnosed with new onset of difficulty if they reported mild to severe difficulty in walking at endpoint. Multivariate logistic regression analyses adjusted for baseline clinical variables were performed to identify predictors associated with new onset of difficulty in walking after one year. **RESULTS** A total of 74 eligible Japanese outpatients (mean age, 65.2±8.2; male, 50.0%) were analyzed in the study. 37 HD patients (50.0%) newly had difficulty in walking 1 km at the endpoint. Adjusted multivariate logistic regression analyses revealed a significant association between new onset of difficulty in walking and leg strength (odds ratio [OR], 0.92; 95% confidence interval [CI], 0.88-0.96;  $P < 0.01$ ), functional reach (OR, 0.86; 95% CI, 0.76-0.96;  $P < 0.05$ ) and presence of orthopedic abnormality (OR, 3.36; 95% CI, 1.01-11.17;  $P < 0.05$ ). **CONCLUSION** Decreased motor function is closely and independently associated with an onset of mobility difficulty in HD patients. **REFERENCES** O'Hare AM, et al. (2003). *Am J Kidney Dis* 41, 447-454. Matsuzawa R, et al. (2012). *Clin J Am Soc Nephrol* 7, 2010-2016. **CONTACT** oxr.seg549@gmail.com

**EXERCISE INTENSITY DOES NOT AFFECT POST-RESISTANCE EXERCISE HYPOTENSION IN TREATED HYPERTENSIVE ELDERLY FEMALES**

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**INTRODUCTION:** Hypertension affects over 50% of the elderly population; therefore it is extremely important to search strategies for prevention and treatment of this disease. Resistance exercise (RE) has been recommended for this population, however, the cardiovascular behavior during and after its end is not completely elucidated. **OBJECTIVE:** To verify the influence of training intensity on post-resistance exercise hypotension (PREH) in treated hypertensive elderly women. **METHODS:** Twenty sedentary treated hypertensive women ( $n = 20$ ; 65 ± 3 years; BMI 30 ± 5 Kg/m<sup>2</sup>; MBP 94 ± 6 mmHg; HR 80 ± 12 bpm) performed two experimental RE sessions (40% and 80% OF 1-MVC) composed by 5 exercises (3 sets; 10-12 reps). Blood pressure (BP) was monitored before (20 min) and after (60 min) the RE sessions. Two-way repeated measures analysis of variance test (ANOVA) (SPSS 14.0 for Windows; SPSS Inc., Chicago, IL, USA) was applied followed by Kruskal-Wallis or Bonferroni's post-hoc test when appropriate.  $P < 0.05$  was accepted as statistically significant. **RESULTS:** Both training intensities caused PREH during the whole period observed, however, no statistical difference was found in SBP (40%: -12 ± 3 mmHg; 80%: -13 ± 2 mmHg), DBP (40%: -6 ± 2 mmHg; 80%: -4 ± 3 mmHg) and MBP (40%: -10 ± 4 mmHg; 80%: -8 ± 3 mmHg). **CONCLUSION:** Our data showed that RE is capable of producing PREH in treated hypertensive elderly women, nevertheless training intensity seems not to influence its magnitude or duration. **REFERENCES:** Chen CY, Bonham AC. (2010). *Exerc Sport Sci Rev*, 38(3): 122-7. Kearney PM, Whelton M,

Reynolds K, Muntner P, Whelton PK, He J. (2005). *Lancet*, 365: 217–223. Pescatello LS, Franklin BA, Fagard R, Farquhar WB, Kelley GA, Ray CA, et al. (2000). *Sports Exercise*, 36:533-53. Queiroz ACC, Gagliardi JFL, Forjaz CLM, Rezk CC. (2009). *Journal of Strength and Conditioning Research*, 23:571-8.

### POSTURAL CONTROL DURING STAR EXCURSION BALANCE TEST

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Postural control during Star Excursion Balance Test Introduction The Star Excursion Balance Test (SEBT) has been used by several authors in the assessment of dynamic balance and lower limb rehabilitation (Plisky et al., 2006; Earl and Hertel, 2001). The aim of the present study was to examine postural control during execution of SEBT by means of body sway and EMG activity of the foot and ankle stabilizers. Methods Eighteen healthy, physically active participants (9 men, 9 women) 27.6 +/- 4.5 years of age, 172.2 +/- 8.2 cm height and 67.1 +/- 13.6 kg body weight, volunteered for the study. The SEBT was performed as described by Robinson and Gribble (2008) with each participant standing on the supportive leg. Postural sway was determined based on the anteroposterior deviation (APd) and mediolateral deviation (MLd) of the center of pressure using a foot pressure platform. The EMG activity of tibialis anterior (TA), peroneus brevis (PB), medial gastrocnemius (GM) and lateral gastrocnemius (GL) was recorded simultaneously during the test and reported as a percentage of each muscle's maximum voluntary contraction (%MVC). Both postural sway and EMG activity was recorded during three attempts of 10-sec each that performed in every direction. Results Our findings revealed that APd was significant greater compared to MLd (13.5 +/- 3.9 mm vs. 7.2 +/- 0.9 mm) regardless of direction ( $p < 0.001$ ). The A, AM and AL directions demonstrated greater APd compared to all other directions (with variable levels of statistical significance). However, the differences between directions with regard to MLd were not significant. The EMG activity of TA was significantly greater (40.7 +/- 13.6 %MVC) compared to PB (24.4 +/- 9.3 %MVC), GL (20.5 +/- 12.7 %MVC) and GM (12.6 +/- 6.5 %MVC) regardless of direction ( $p < 0.001$ ). However, TA and PB EMG activity was less in the A, AM and AL direction compared to the other directions (with variable levels of statistical significance). Discussion The findings of the present study suggest that the human body during SEBT is swayed primarily in anteroposterior direction and postural control is ensured, at least as far as the ankle and foot dynamic stability is concerned, by the activation of TA and PB. The direction-dependent differences, with regard to APd, could be justified by the differences in the EMG activity of TA and PB. The higher APd in A, AM and AL directions compared to ML and P directions may be explained by the lower EMG activation recorded by the TA and PB muscles. Conversely, the greater activation of TA and PB in ML and P directions may enhance postural control, resulting in lower APd in these directions. References Plisky et al., *J Orthop Sports Phys Ther* 2006; 36:911-19 Earl & J. Hertel, *J Sport Rehabil* 2001; 10: 93-104 Robinson & Gribble, *Arch Phys Med Rehabil* 2008; 89:364-70 Contact iatridou@phed.uoa.gr

## Mini-Orals

### MO-PM28 Sports Medicine and Orthopedics: Mixed session I

#### EFFECTS OF INTERVAL EXERCISE TRAINING ON BLOOD PRESSURE AND ENDOTHELIAL FUNCTION IN PRE- AND HYPERTENSIVE PATIENTS

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Background: Recently, several studies have shown that interval exercise training (IT) is superior to continuous aerobic exercise (CE) for improvement on endothelial function in hypertensive patients. However, little is known about its effects on changes in blood pressure, especially in hypertensive patients. Purpose: To compare the effects of IT and CE on changes in blood pressure reduction and endothelial function in pre- and hypertensive patients. Methods: Seventeen pre- and hypertensive patients, aged 52.1±7.6, participated in this study, tapered off their medications, if necessary, and were randomized to either IT (n=9) or CE (n=8) group. IT was composed of 5 sets of 3 min exercise at 80% HRR, and each interval was separated by 3 min recovery at 40% HRR. CE was composed of 35 min exercise at 60% HRR. Both groups were designed to use same energy expenditure, and performed exercise 5 days per week for 4 weeks. Endothelial function was determined by assessing endothelial progenitor cells (EPCs) using flow cytometry and flow mediated dilation (FMD) using ultrasonography. Arterial stiffness was measured by pulse wave velocity (PWV). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured at rest and during exercise at 60% HRR by using automatic blood pressure monitor. Results: At rest, SBP was significantly decreased in IT ( $p < 0.01$ ) and CE ( $p < 0.05$ ), and DBP was significantly decreased in IT ( $p < 0.001$ ), but not in CE. During exercise, SBP was significantly decreased in CE ( $p < 0.05$ ), but not in IT, and DBP was significantly decreased in IT ( $p < 0.01$ ), but not in CE. FMD and EPCs were significantly improved in IT ( $p < 0.01$  and  $p < 0.05$ , respectively), but not in CE. There were significantly different changes in DBP during exercise and EPCs between groups ( $p < 0.05$ ). However, PWV was not changed in both groups. Conclusion: The results of this study suggest that IT and CE equally have beneficial effects on blood pressure reduction at rest and during exercise. However, IT may improve endothelial function greater than CE. Therefore, IT could be a better exercise program than CE for pre- and hypertensive patients. Contact e-mail: jiparkpnu@pusan.ac.kr

#### THE EFFECT OF HIGH-INTENSITY INTERVAL EXERCISE AND RESISTANCE EXERCISE ON BLOOD PRESSURE IN NON-OBESE ADULTS\*

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Shi, Q.1, Kong, Z.2, Lin, H.3, Tong, T.4, Leong, K1, Nie, J.1:1 MPI (Macao, China). 2: UMAC (Macao, China). 3: LNU (Dalian, China). 4: HKBU (Hong Kong, China). Introduction Current recommendations for blood pressure (BP) control involve performing prolonged endurance and resistance exercise. However, the general population fails to follow such regimes due to lack of time. Therefore, it is very important to develop time-efficient exercise intervention strategies. A growing body of evidence demonstrates that minimal volume of high-intensity interval training and resistance training can serve as effective alternates to traditional time-consuming training, inducing similar or even superior physiological adaptations (Babraj et al., 2009). However, limited information is available regarding the impact of minimal vol-

ume exercise on BP. The study aimed to analyze BP responses in non-obese adults following minimal volume high-intensity interval exercise (HIE) and resistance exercise (RES). Methods Twelve non-obese adults (age: 24.3±2.3 years; BMI: 20.8±1.7) underwent: (1) HIE: all-out cycling exercise 30 sec × 4, interspersed with 4 min of rest; (2) RES: a circuit of nine resistance exercise involved the large muscle groups with ten repetitions, interval with 1 min of rest; and (3) CON: a control session of no exercise. Systolic (SBP), diastolic (DBP) and mean arterial (MAP) were measured by ambulatory blood pressure monitoring (ABPM) over a 15 hrs period following exercises and CON, including daytime and nighttime. Results Compared with CON, only RES elicited post-exercise DBP (CON vs. RES: 72±11 vs. 68±12 mmHg) and MAP (CON vs. RES: 94±11 vs. 91±12 mmHg) reduction that lasted 40 min after exercise (P<0.05). Also, the mean SBP (CON vs. RES: 114±8 vs. 117±7 mmHg), DBP (59±4 vs. 56±4 mmHg) and MAP (77±4 vs. 74±4 mmHg) during sleep were lower following RES (P < 0.05). Discussion Though hypertension is the most common chronic condition in more than 40 yr olds, preventing the induction of hypertension in 20-40 yr olds is as important as treating the later stages of the disease. The results of the present study demonstrate that, compared with no exercise and HIE, minimal volume RES (total exercise period of 14 min) was effective in promoting hypotension effects in BP in normotensive adults, as measured by ABPM. It is known that responses to physical training are the result of cumulative acute effects over time (Thompson et al., 2001). Therefore, the current findings led the authors to speculate that minimal volume resistance exercise involved the large muscle groups may represent a time-efficient tool for hypertension prevention in young subjects. \*The study was supported by a research grant from Macao Polytechnic Institute (RP/ESE FD-02/2012). References Babraj JA, Vollaard NB, Keast C (2009). BMC Endocr Disord, 28;9:3. Thompson PD, Crouse SF, Goodpaster B (2001). Med Sci Sports Exerc, 33(6 Suppl), S438-S445. Contact qdshi@ipm.edu.mo

### PREVALENCE AND CHARACTERISTICS OF EARLY REPOLARIZATION IN MACAO AMATEUR MALE ATHLETES' ELECTRO-CARDIOGRAM \*

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Nie, J.1, Kong, Z.2, Lin, H.3, Tong, T.4, Wang, K. 1, Shi, Q.1 1: MPI (Macao, China). 2: UMAC (Macao, China). 3: LNUU (Dalian, China). 4: HKBU (Hong Kong, China). Introduction Early repolarization (ER), defined as QRS slurring and/or a J-wave on the electrocardiogram (ECG) is found in over 5% of the general European population, and more frequent in athletes. It has long been considered as a normal variant and even an ECG marker of good health (Tikkanen et al., 2009). However, this view was recently challenged by some large population studies demonstrated that ER was associated with reduced overall survival and an increased risk for arrhythmic death (Tikkanen et al., 2009). The purpose of this study was to assess the prevalence and characteristics of ER in Macao amateur male athletes. Methods The 12 lead ECGs recorded in digital form of 106 Macao amateur male athletes (age: 24.0±5.6 years), of Chinese Han ethnicity, with a normal cardiovascular physical examination and without family and personal history of heart disease, were analyzed. In this study, there were 5 different definitions of ECG abnormalities (Type 1-5), which are currently being associated with so called early repolarization. Types 1, 3 and 5 all have an elevated ST amplitude>0.1 mV with or without a notch or slur while Types 2 and 4 have the peak of a notch or onset of a slur>0.1 mV but without ST elevation (Macfarlane et al., 2013). Results Overall, 84.9% of the population studied had one or other form of "early repolarization" defined as one of the five patterns illustrated with the inclusion of ST elevation. Specifically, the prevalence in Type 1-5 was 25.5%, 21.7%, 5.7%, 9.4% and 83.0%, respectively. Discussion Few trials have compared origin of individuals exhibiting ER. To our knowledge, this study is the first to evaluate the prevalence of ER pattern in a athlete population of Chinese Han ethnicity. Macfarlane et al. (2013) in a study of 859 ECGs recorded in Caucasians found that 35% had any form of ER 35% if ST elevation is not considered part of the definition, and 3.3% with the inclusion of ST elevation. These data are far lower than those obtained in our study, particularly in relation to ST elevation. Thus, the associations between ER and cardiac structure and function is worthy of further enquiry. Further, longitudinal investigation is warranted into the long-term significances of different type of ER. \*The study was supported by a research grant from Macao Polytechnic Institute (RP/ESEFD-01/2012). References Macfarlane PW, Clark EN, Heng JS (2013). J Electrocardiol, 46, 505-509. Tikkanen JT, Anttonen O, Junttila MJ, Aro AL, Kerola T, Rissanen HA (2009). N Engl J Med, 24, 2529-2537. Contact jnie@ipm.edu.mo

### EFFECT OF MUSIC TYPE ON HEART RATE VARIABILITY DURING RECOVERY FROM MODERATE INTENSE EXERCISE

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Introduction Listening to music not only makes people feel delighted but helps them release their pressure. Previous studies have shown that music can affect the human automatic nervous system and lead to decreased blood pressure and heart rate (Yamasaki et al., 2012). Therefore, the purpose of this study was to discuss the effect of music type on the heart rate variability (HRV) during recovery after engaging in cycling exercise Methods Twelve healthy male college students aged 19.7±0.7 years old were recruited in this study. Every subject participated in three testing conditions randomly including listening Latin, classic and without music after cycling exercise. Cycling intensity was set at resistance of 120W and cycling speed must maintain at 60 rpm for 15 minutes. After exercise, subjects walked on the treadmill at constant speed of 3 km/h and listened the music at the same time. The heart rate was detected at the time 1, 3, 5, 10, 15 minutes after exercise and HRV were analyzed every five minutes after exercise. Results The results showed that the high frequency (HF) of HRV is higher when listening Latin music during recovery especially during 10-15 minutes after exercise reached significant than without music. Moreover, the heart rate decreased rate also faster when listening Latin music than without music 15 minutes after exercise. Discussion Previous study indicated that HF component of HRV could represent the stimulation of the parasympathetic nervous system (Hayano et al., 1991). The results in this study showed that HF of HRV is significantly higher when listening Latin after exercise than without music, which may represent listening Latin music could activate Parasympathetic nerves more after exercise. In addition, this study also found that the heart rate recovered when listening Latin was faster than without music. Listening Latin music could stimulate parasympathetic nervous system and could recover the heart rate quickly after moderate exercise. References Yamasaki A., Booker A., Kapur V., Tilt A., Niess H., Lillemo KD., Conrad C. (2012). Nutrition, 28(11), 1075-1080. Hayano J, Sakakibara Y, Yamada A, Yamada M, Mukai S, Fujinami T, Yokoyama K, Watanabe Y, Takata K. (1991). Am J Cardiol., 67(2), 199-204. Contact susan40935@gmail.com

## EXERCISE PERFORMANCE IMPAIRMENT IN AN ELITE ENDURANCE ATHLETE AND HORMONAL CONTRACEPTIVE: IS THERE A LINK? CASE REPORT

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**Introduction** There is a cumulative number of anecdotal cases of a decline in performance in elite female athletes who use hormonal contraceptives (HC), (1). Given the widespread use of HC in athletes with an estimated similar prevalence as in the general population a potential effect on exercise performance is of particular relevance (2). The purpose of this single case study is to raise awareness regarding the possible impact of HC on exercise performance and health. **Methods and Results** A 23-yr-old female highly trained endurance biathlete (VO<sub>2</sub>max 62.0 ml.kg<sup>-1</sup>.min<sup>-1</sup>, BMI 19.5 kg/m<sup>2</sup>, whole-body fat 12.6 %) complained about a severe decline in exercise performance over a period of 5 months after the athlete had begun to use a low dose vaginal NuvaRing HC. Two to three months after first taking HC she reported chronic fatigue and being unable to train within her normal exercise capacity. Resting heart rate (HR) was increased from her normal value avg. 44 to 62 bpm and blood pressure was increased from avg. 105/70 to 142/85 mmHg. Values of the active orthostatic HR-test (H. Rusko) were increased for the 90-120th sec after standing up from 75 to 109 bpm. She was incapable of achieving an adequate race performance (max. HR 175 bpm compared with her norm of 185 bpm). The athlete experienced extreme dizziness, vertigo, tunnel vision during racing and visual problems while target shooting. She reported repeated sudden sweating and hot flashes induced by high intensity exercise. After differential diagnosis including cardiac dysfunction, electrolyte imbalance, iron deficiency and thyroid gland disorder the athlete was advised to discontinue HC. Subsequently symptoms disappeared within 2 months. **Discussion** The athlete, while using HC, was diagnosed with circulatory dysregulation and impaired exercise performance, which resolved upon HC discontinuation thus supporting evidence from the literature of HC to have serious implications on performance in training and competition. Reported potential effects are e.g. a 5-13 % reduction in VO<sub>2</sub>max (2), increased core body temperature and change in sympathetic control of blood pressure (3). Because there is no awareness of a possible coherence and considering that the smallest worthwhile change in elite athletes performance decides over winning a competition, it is most important to advise athletes on potential adverse effects of HC on exercise performance. **References** (1) Little C (cited 2011 Aug 17). [Http://Fasterskier.com](http://Fasterskier.com). (2) Burrows M & Peters CE (2007). *Sports Med*, 37, 557-74. (3) Minson CT et al. (2000). *Circulation* 102, 1473-76. Katja.Heinicke@uni-bayreuth.de

## EFFECT OF MUSIC TYPE IN LACTATE CLEARANCE AND CARDIOPULMONARY SYSTEM AFTER MODERATE INTENSE EXERCISE

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**Introduction** Previous studies assessing the recovery from high-intensity exercise demonstrated that active recovery was more efficient than the passive one, for removal of lactate from the blood and for restoring exercise capacity. The research found that the motivational music during recovery could increase lactate clearance after exercise. However, this research did not control the steps rate, so that removal of lactate may not only vary from music (Eliakim et al., 2012). Our purpose was to investigate how Latin and classical music affect cardiopulmonary function and lactate clearance under fixed step rate after moderate exercise. **Methods** Twelve healthy male college students aged 19.7±0.7 years old were recruited in this study. Every subject participated in three testing conditions randomly including listening Latin, classic and without music after cycling exercise. Cycling intensity was set at resistance of 120W and cycling speed must maintain at 60 rpm for 15 minutes. After exercise, subjects walked on the treadmill at constant speed of 3 km/h and listened the music at the same time. The VO<sub>2</sub>, VCO<sub>2</sub>, R, RF, RPE, and Lactate intensity were detected at the time 1, 3, 5, 10, 15 minutes after exercise. **Results** The results found that there is no significance difference in VO<sub>2</sub>, VCO<sub>2</sub>, R, RF and RPE between three conditions during recovery. With regard to Heart recovered rate in 15 minutes, Latin was significantly faster than without music. Besides, lactate clearance in 3-15 minutes is significantly faster with Latin music than without music. **Discussion** Previous study showed that relaxing music could not help heart rate recovery after exercise (Tan et al., 2014). However, this study found that listening Latin after exercise let the heart rate recover more quickly than without music that may represent different music type have different effect in cardiovascular function after exercise. Moreover, Latin music also could help lactate clearance more rapidly. The previous research demonstrated that listening to the motivational music got more steps which benefited the lactate clearance (Eliakim, 2013). This study proved that, even at the same steps rate, listening Latin music still could have faster lactate clearance and heart rate recovery. This study shows that listening Latin after exercise could help cardiovascular system recovery. **References** Eliakim M, Bodner E, Eliakim A, Nemet D, Meckel Y. (2012). *J Strength Cond Res*, 26(1), 80-86. Tan F, Tengah A, Nee LY, Fredericks S. (2014). *Complement Ther Clin Pract*, 20(2), 114-117. Eliakim M, Bodner E, Meckel Y, Nemet D, Eliakim A. (2013). *J Strength Cond Res*, 27(4), 1019-24. Contact u101009020@kmu.edu.tw

## PHYSICAL ACTIVITY AND GESTATIONAL WEIGHT GAIN, POSTPARTUM WEIGHT RETENTION AND INFANT'S BIRTH WEIGHT AMONG WOMEN AT RISK OF GESTATIONAL DIABETES

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**Introduction** Regular physical activity during pregnancy is recommended for all healthy women during pregnancy and postpartum due to its marked benefits for the mother and the fetus. Physical activity may, for example, be effective in reducing excessive gestational weight gain (GWG), which is associated with short- and long-term health problems such as mother's higher postpartum weight retention (PPWR) and infant's higher birth weight (BW). To prevent this, health care professionals need information about the associations of physical activity with lower GWG, PPWR and infant's BW in this specific target group. The aim of this study was to examine the association of pre-pregnancy leisure-time physical activity (PreLTPA) and changes in LTPA during pregnancy (ChalTPA) with GWG, PPWR (at 8-10 weeks' postpartum) and infant's BW in Finnish women at risk of gestational diabetes. **Methods** The cohort study consisted of 399 pregnant women. Assessment of LTPA was based on self-report at 8-12 (recall on PreLTPA), 26-28 and 36-37 weeks' gestation, and was divided into two domains: 1) LTPA excluding domestic activities, and 2) LTPA including domestic activities. Data on GWG, PPWR, and infant's BW were based on measurements except the self-reported pre-pregnancy weight. Linear regression was used to assess associations between LTPA with and without domestic activities with GWG, PPWR and infant's BW. **Results** The women with 61-180 of light- or 61-120 weekly minutes of moderate-intensity PreLTPA excluding domestic activities had lower GWG (adjusted coeff. -1.43, 95% CI -2.81 to -0.06; adjusted coeff. -1.53, 95% CI -2.94 to -0.12) in comparison with less active women. Similar association was discovered between 61-120 weekly minutes of moderate-intensity PreLTPA excluding domestic activities and lower PPWR (adjusted coeff. -2.08, 95% CI -3.91 to -0.25). More

than 90 weekly minutes of vigorous-intensity PreLTPA including domestic activities were associated with lower infant's BW (adjusted coeff. -140.8, 95% CI -262 to -19.6). In ChalTPA statistically significant associations were not found. Discussion More than one hour of light- or moderate-intensity PreLTPA excluding domestic activities associated with lower GWG and PPWR, whereas more than one hour of vigorous-intensity PreLTPA including domestic activities associated with lower infant's BW. The findings suggest that pre-pregnancy physical activity should be promoted in order to reduce excessive GWG, PPWR and infant's BW.

## Mini-Orals

### MO-PM30 Sports Medicine and Orthopedics: Gender

#### OXIDANT/ANTIOXIDANT MARKERS IN FEMALE SOCCER PLAYERS WITH AND WITHOUT PREMENSTRUAL SYNDROME

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1:UNIFESP; 2:UNICSUL

**Introduction** In a study of David et al (2009), it was shown that PMS affect the performance of female athletes. PMS is defined as a group of physical and behavioral changes starting during the luteal phase and ending during menstruation (Usman et al, 2008). It is also known that intense physical activity is closely associated with the development of oxidative stress (Cooper et al, 2002). It's noteworthy the lack of studies in the literature relating the production of free radicals in female athletes with PMS. The aim of this study was to evaluate oxidant/antioxidant markers in female soccer players with and without PMS in 4 moments: before (pre) and after (post) the game and in the two phases of the menstrual cycle: follicular and luteal. **Methods** Fifty-two eumenorrheic soccer players were evaluated (age :19.8±4.7). The PMS and phases of the menstrual cycle were determinate by monitoring for 3 consecutive months. Evaluation of oxidized Low Density Lipoprotein (oxLDL), Human Anti Oxidized Low Density Lipoprotein antibody (anti-oxLDL), Total Antioxidant Status (TAS) and Peroxide were performed in urine and quantified by ELISA method. The study protocol was approved by UNIFESP Research Ethics Committee (No.1604/10). For data analysis we used ANOVA and Pearson correlation with significance level of 5%. **Results** We were able to show an increase of oxLDL ( $p<0,005$ ) post game in luteal phase, TAS ( $p=0,008$ ) and peroxide ( $p<0,005$ ) post game in follicular phase only in the group without PMS. The correlation analysis revealed a positive correlation between oxLDL and TAS post game in follicular ( $p<0,005$ ) and luteal ( $p=0,03$ ) phases only in PMS group. In addition there was a positive correlation between oxLDL and anti-oxLDL post game in follicular phase ( $p=0,01$ ) only in PMS group. **Discussion** The findings of our study suggest that mechanism controlling the production of free radicals is expressed differently in the group with PMS. Hormonal fluctuations and neurotransmitters that act in PMS may have influence on oxidative stress. We emphasize the importance of detection and monitoring PMS in female athletes as a tool to improve performance and protect athletes' health. **References** David AM et al. Incidência da Síndrome Pré-menstrual na Prática de Esportes. Rev Bras Med Esporte. 2009; 15(5): 330-333. Usman SB et al. Hormonal management of premenstrual syndrome. Best Pract Res Clin Obstet Gynaecol. 2008;22(2): 251-60. Cooper CE et al. Exercise, free radicals and oxidative stress. Biochem Soc Trans. 2002;30:280-5. email: robertafoster@ig.com.br

#### GENDER DIFFERENCES IN KNEE ABDUCTION DURING WEIGHT-BEARING ACTIVITIES: A SYSTEMATIC REVIEW AND META-ANALYSIS

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**Background** Women are reported to have a higher prevalence of patellofemoral pain syndrome (PFPS) and anterior cruciate ligament (ACL) injury than men. Increased knee abduction during weight-bearing activity is suggested to be a contributing factor, but results from different studies are inconclusive. **Objective** The aim was to systematically review gender-differences in knee abduction during weight-bearing activities in individuals with or without knee injury. **Data sources** A systematic review and meta-analysis were conducted according to the PRISMA guidelines. A search in the databases Medline (PubMed), CINAHL and EMBASE (OVID) was performed in December 2014. **Study selection** Inclusion criteria: Studies including weight-bearing lower extremity functional tasks and 1) investigating gender differences in knee abduction/knee medial to foot position, 2) including healthy men and women and/or those with ACL injury or PFPS, and 3) assessing knee abduction in degrees in either a two-dimensional or three-dimensional motion analysis system, and/or medio-lateral knee position by visual observation. **Data extraction** Study year, type of subjects (healthy, ACL injury or PFPS), number of participant, gender, outcome measure (knee abduction in degrees or visual observation), time point for the assessment (initial contact, peak knee abduction or knee abduction excursion), functional task and effect size were extracted from the studies. **Synthesis of results** Meta-analyses were performed on three studies for patients with knee injury and on 51 studies for healthy individuals. Females with knee injury had increased peak knee abduction compared to their male counterparts (Std diff in mean; -1.16, SE; 0.18, 95%CI; -1.52 to -1.80). In healthy individuals, women performed weight-bearing tasks with increased knee abduction throughout the movement (initial contact; Std diff in mean; -0.65, SE; 0.15, 95%CI; -1.43 to -0.36, peak knee abduction; Std diff; -0.82, SE; 0.12, 95%CI; -1.06 to -0.58 and knee abduction excursion; Std diff; 0.72, SE; 0.17, 95% CI; -1.05 to -0.40). Subgroup analyses for weight-bearing tasks revealed that jump landings, cutting and running were best at discriminating between men and women, whereas there were no gender-differences for drop jump or single-leg squat. **Conclusion** Increased knee abduction during weight-bearing activity is more common in women than in men. Thus, this may be a contributing factor to the gender-difference in knee injuries.

#### THE EFFECT OF ORAL CONTRACEPTIVES ON ATHLETIC PERFORMANCE IN FEMALE ATHLETES.

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**[Introduction]** In Japan, the use of oral contraceptives (OC) in female athletes is low (2%)(Ogura-Nose et al., 2014). The prevalence of dysmenorrhea and premenstrual syndrome (PMS) in elite female athletes in Japan are 25.6 % and 70.3% respectively (Ogura-Nose et al., 2014). The use of OC is necessary as treatment for PMS and menstrual cycle control in addition to dysmenorrhea. However, the effect of

OC on athletic performance is unclear. The purpose of this study was to examine the effect of OC on endurance performance. [Method] Eight female athletes were recruited. All subjects were examined during the menstrual (M) phase, follicular (F) phase, ovulatory (OV) phase, and luteal (L) phase. In addition all subjects were examined during the OC phase (days 10-20 of their OC use) and withdrawal-bleeding (W) phase (days 2-5 post OC phase). Subjects were enrolled randomly during different phases in the menstrual cycle to prevent examiner bias. Phase of the menstrual cycle was confirmed by plasma estrogen and progesterone levels. After natural menstrual cycle tests, all subjects began taking OC. A monophasic oral contraceptives with ultra low-dose (ethinylestradiol: 0.02mg, norethisterone: 1mg) was used. The same measurements were taken once two months after taking OC and during W phase. Post-exercise cardiovascular reactivation test, lactate curve test, and VO<sub>2</sub>max tests were performed during all phases. All parameters were first analyzed by one-way analysis of variance for repeated measurements. All data are presented as means  $\pm$  SD, and a P value of  $< 0.05$  was considered statistically significant. The change in individual measurements due to taking OC was compared using typical error (TE)(Hopkins, 2000). [Results] No changes in resting indexes or endurance performance tests during all phases (among natural cycle, OC phase, and W phase) were observed. Thus, no effect was observed on a natural period. In addition, taking OC did not affect resting indexes or endurance performance. However, when focusing on individual differences, the possibility of increased VO<sub>2</sub>max of for athlete A existed (TE=1.8) in both the W phase (4.2) and L phase (3.7) compared with the F phase. On the other hand, in the case of athlete B, the possibility of decreased VO<sub>2</sub>max existed (TE=1.4) in the L phase (-1.7), the OC phase (-3.1), and W phase (-1.6) compared with the F phase. [Summary] These results suggest that endurance performance did not change during the natural menstrual cycle. As for the effect of taking OC on endurance performance, it is possible that a difference was not recognized because there are great differences between individuals. Therefore, when considering the effect of OC on endurance performance, it is important to consider individual differences.

### CROSSFIT INJURIES – A DESCRIPTIVE SURVEY-BASED RETROSPECTIVE STUDY

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**Introduction** CrossFit is a combined strength and conditioning fitness program with varied movements performed at a high intensity. Although CrossFit have attained a reputation of being associated with considerable injury risk, only few studies have examined the prevalence of CrossFit-related injuries (Hak PT et al., 2013 & Weisenthal BM et al., 2014). The aim of the present study was to determine the prevalence, the anatomical location and types of injuries in Danish CrossFit athletes. **Material and methods** In November 2014, an email was sent to all members of a local Danish CrossFit gym asking them to complete an online-based, study-specific survey. Participants were asked to self-report current CrossFit-related injuries, including questions on type, location, duration, and characteristics of CrossFit-related injuries. In addition, participants were asked to report time to recovery (number of missed training days), absence from work due to injury, and medical attention. This approach corresponds to the first step in the sequence of prevention, where the extent of the injuries must be identified and described (van Mechelen W et al., 1992). **Results** In total, 930 (29% females) of 1,423 members completed the online survey corresponding to a response rate of 65%. The median age was 26 (IQR: 24-32). At time of data collection, the overall injury prevalence was estimated at 13% (95% CI: 10.8 to 15.3), with 18 participants reporting multiple injuries. Current injuries were most frequently located to the shoulders (n=48, 34.3%) followed by knees (n=26, 18.6%) and lower back (n=16, 11.4%). **Conclusion** To the best of our knowledge, this is the largest study on CrossFit-related injuries. An overall injury prevalence was estimated at 13%, with shoulders, knees and lower back being the most common anatomical locations of injury. Our findings are in concordance with initial studies of CrossFit-related injuries. These findings also call for larger, prospective studies using a standardized survey to examine in detail the identified injury patterns, with the end goal being development of injury prevention strategies. This would also enable comparison of CrossFit-related injuries across studies and sports. **References** Hak PT et al. (2013). *J Strength Cond Res*. Epub ahead of print, Weisenthal BM et al. (2014). *The Orthopaedic Journal of Sports Medicine*, 2(4), 2325967114531177. van Mechelen W et al. (1992). *Sports Med*, 14:82-99. Contact christian.larsen@rm.dk

### THE DIFFERENCES OF SHOULDER ROTATION AGONIST/ANTAGONIST TORQUE RATIO BETWEEN BASEBALL PLAYERS AND NON-PLAYERS IN DIFFERENT TESTING VELOCITIES AT VARIOUS JOINT POSITION

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**Introduction** Baseball players have to sustain large loading in shoulder and require strong muscles co-contraction to keep joint stability. The agonist/antagonist strength ratio is one of the indicators to evaluate the joint stability condition in different group. Moreover, the rotational velocity and joint angle are the factors could affect muscle strength that may also change the ratio. The purpose of this study was to investigate the difference the rotational agonist/antagonist strength ratio between baseball players and untrained subjects in different shoulder abduction angle at various rotational velocities(Stodden, Fleisig et al. 2005). **Methods** Nine subjects including five baseball players who played for their university and four university students, aged 20-23, without any upper limb injuries were recruited in the study. In the isokinetic shoulder internal and external rotation concentric strength test, the joint strength was measured by the dynamometer system (System 3, Biodex Medical Systems, USA) in the rotational velocity 60°/sec, 120°/sec and 210°/sec at shoulder abduction 45°, 70° and 90°(Manske, Tajchman et al. 2004). **Results** The internal rotation peak torque of the subjects showed significant differences in different position, and baseball players had larger strength, moreover, the position had interaction with group ( $p < 0.05$ ). The peak external rotation torque also could find significant differences in different positions, rotational velocities ( $p < 0.001$ ), and baseball players also have larger external rotation strength ( $p = 0.023$ ). The ratio of internal/external rotation peak torque had significant differences in different testing velocities and groups ( $p < 0.001$ ). **Discussion** This study found that the joint position and rotational velocities did affect the shoulder rotational strength. However, the rotational velocity had little effect in internal rotation strength, that may result from throwing motion is a common exercise during daily activity, the subjects adapted different throwing velocities(Mulligan, Biddington et al. 2004). We also found that the ratio of internal/external rotation strength was also different at different velocities, higher velocity had higher ratio, that may show the change of internal rotator strength with velocities increase did not the same with external rotators. The shoulder joint have different stability condition at different rotational velocities. Moreover, the ratio was also different in the group. In order to prevent injury, the baseball players have different muscles power to keep joint stability. This information could provide the athletes trainers, coaches, and players for better design muscle strengthening program for prevent injury.



**PREVENTION OF ANTERIOR CRUCIATE LIGAMENT INJURIES IN COMPETITIVE ALPINE SKIERS**

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**INTRODUCTION.** There is a high risk for alpine ski students to sustain an injury during their education at a Swedish Ski High School. Westin et al (2012) reported that the knee was the most common localization of an injury in both male and female skiers. Furthermore, both genders were more likely to sustain injuries to their left than to their right leg. Anterior cruciate ligament (ACL) injury was found to be one of the most severe injuries in elite alpine ski students. An ACL injury often forces the skier to stop skiing for several months. Moreover, an ACL injury often leads to multiple problems from a physiological, psychological, social and economical point of view. Therefore, ACL injury prevention is important and to the best of our knowledge no earlier study on ACL injury prevention has been performed in competitive alpine skiers. **METHOD.** This study represents the fourth step of van Mechelen's "Sequence of prevention" (van Mechelen et al, 1992). The implementation of preventive strategies has been preceded by an injury profile identifying both intrinsic and extrinsic risk factors in competitive alpine skiers. All alpine skiers studying at a Swedish Ski High School between 2011 and 2013 represented an intervention group, while alpine skiers who studied at a Swedish Ski High School between 2006 and 2010 served as controls. Based on injury mechanism and risk factors a professional video film was developed trying to reduce severe knee injuries in alpine skiers. The intervention group watched this film during two seasons. In September 2011 all ski coaches were taught how to implement prevention strategies using different exercises. During the first year the alpine ski students watched the film 1-10 times. Regular contacts (phone calls and e-mails) were continuously performed with each school. At the end of the first season all schools were visited by the principal test leader (MW) to check injury recordings and how they performed the exercises for possible knee injury prevention. A questionnaire was used for checking compliance of the performance of these exercises. At the end of the second season a meeting with the ski coaches was held in order to verify the data collected during these years. **RESULTS.** To be presented at the conference **DISCUSSION AND CONCLUSIONS.** To be given at the conference not insert authors here

**THE LONG-TERM USE OF LONG ACTING  $\beta_2$ -AGONISTS IMPROVES SPRINT AND STRENGTH PERFORMANCE.**

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**The Long-Term Use of Long Acting  $\beta_2$ -Agonists Improves Sprint and Strength Performance.** Background: Long-acting  $\beta_2$ -Agonists can be used on a daily basis by athletes to protect against bronchoconstriction; therefore athletes prescribed with long-acting  $\beta_2$ -Agonists take this on a daily basis for a prolonged period of the time. Limited data is available regarding the ergogenic effects of long acting inhaled  $\beta_2$ -agonists. It is unknown whether the long-term use of long acting  $\beta_2$ -Agonists improves sprint and power performance. Purpose: To investigate the impact of inhaling 100  $\mu$ g of salmeterol (SAL) or 12  $\mu$ g of formoterol (FOR) twice daily over a 10 week period on 30 m Sprint Performance and 1RM Leg Press in competitively active male athletes. Methods: 21 male non-asthmatic competitively active participants were recruited (mean  $\pm$  SD; age  $28 \pm 5.5$  years; weight  $72.1 \pm 10.5$  Kg; height  $164.7 \pm 7.1$  cm). In a randomised single blind design participants were asked to inhale doses of either 100  $\mu$ g of salmeterol (SAL), 12  $\mu$ g of formoterol (FOR) or placebo twice daily over a 10 week period. Over the course of the 10 weeks period participants attended 37.5 hours of resistance training split into 30 sessions. All the training sessions were supervised by a personal trainer who recorded the weight lifted during each session. Participants performed a 30 m sprint and 1RM Leg Press at baseline, 5 weeks and 10 weeks. 3 x 3 Repeated measures ANOVA was used to investigate the changes in sprint performance and 1RM Leg Press. Results: Over the course of the 10 week training programme 30 m sprint time improved significantly in both SAL and FOR groups when compared with PLA (-0.61s and -0.44s) ( $p < 0.001$ ). Over the 10 weeks period improvements in 30 m sprint performance did not differ between SAL and FOR. Significant improvements in sprint performance were observed in SAL and FOR from baseline to the 5 weeks mid-test assessment when compared to PLA (-0.38s; 0.56s) ( $p < 0.01$ ). No significant improvements in 30 m sprint time were observed between SAL, FOR and PLA in the last 5 weeks of training. Over the 10 week training period 1RM significantly improved ( $p = 0.047$ ) in SAL ( $179.63 \pm 35.52$  kg) and FOR ( $133.79 \pm 77.5$  kg) when compared to PLA ( $101 \pm 78.94$  kg). Discussion: This study is the first to demonstrate 10 weeks of inhaling either SAL or FOR results in a significant improvement in 30 m sprint and 1RM Leg Press. Future research is required to investigate whether the mechanism for the improvement in 30 m sprint and Leg Press is as a result of improved muscle function or central control. The findings would suggest WADA may consider re-introducing the requirement for therapeutic use exemption certificates for athletes requesting to use SAL and FOR during training and competition.

**BALANCING THE IMBALANCE OF STROKE SURVIVORS WITH BACKWARD SLOPE WALKING ON DIFFERENTIAL TREADMILL GRADIENTS**

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**ABSTRACT** The purpose of this study was to balance the imbalance of stroke survivors by using backward slope walking on differential treadmill gradients to challenge the cardiovascular and neuro-muscular systems and by synthesizing an analysis of lower limb biomechanics during this task. Thus, a total of thirty (30) stroke survivors randomly drawn participated in this study. Balance and co-ordination were tested in relation to backward slope walking on differential treadmill gradients (0, 5 and 10). Analysis of covariance was used to test the hypotheses at 0.01 level of significance. The F-values of 68.80\* and 33.32\* for balance and coordination were respectively found to be statistically significant at 0.01. Turkey HSD was used to determine the source of the significant difference among the groups. It was discovered that there was a significant difference at 10 gradient compared to 5 and 0 gradients ( $10 > 5 > 0$ ) in the balance and co-ordination of the participants. It was therefore recommended that backward slope walking should be used as an additional component in intervention/rehabilitation programme to provide cardiovascular fitness, balance control/proprioception by increasing the amount of blood pump at each stroke and the efficiency of the heart of stroke survivors.

## BMC AND BMD OF MIDDLE-AND OLD-AGED MALES UNDERGOING SHUTTLECOCK KICKING WITH DIFFERENT STYLES AND DURATIONS

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Objective: Kicking shuttlecock is a popular traditional sport in china, the purpose of this study is to compare and explore the BMC and BMD of middle-and old-aged males who underwent shuttlecock kicking with different styles duration. Methods: Twenty seven subjects, aged 40-60 years of kicking shuttlecock 5times a week,2 hours per time, were selected ,and divided into following groups according to their kicking styles leg and durations: group I : kicking with double legs for 3 to 12 years (n =13),group II : kicking with single leg for 1 to 3 years(n =14),and control group: rarely kicking(n =16).The BMC and BMD of skull, thoracic vertebrae, lumbar vertebrae, pelvis, non-dominant arm, dominant arm, left ribs, right ribs, non-dominant leg and dominant leg were analyzed by dual-energy X-ray absorptiometry (EDXA) and their differences were compared among the three groups. Results: BMC and BMD in 10 parts of body in groups I and II were significantly higher than that in control group( $P < 0.05$ ,  $P < 0.01$ ); BMC and BMD of legs, non-dominant leg and pelvis in group II were significantly higher than in control group( $P < 0.05$ ,  $P < 0.01$ ). BMC in all tested parts except right ribs, and BMD in all 10 tested parts in group I were significantly higher than that in control group( $P < 0.05$ ,  $P < 0.01$ ).The BMD of non-dominant leg in group II was significantly higher than in group I ( $P < 0.01$ ). Conclusion: Long-term shuttlecock kicking for middle-and old-aged individuals revealed a greater acquisition of BMC and BMD in almost the whole body. Prolonged kicking duration could cause more acquisition of BMC and BMD, especially in the legs and pelvis. Long-term single-legged kicking seemed to be resulted in unbalanced BMD development of legs.

## Mini-Orals

### MO-PM32 Sport Technology

#### QUANTITATIVE, MULTISCALE PROFILING OF MOTION AND ACTIVITY IN CHILDREN

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Introduction The de facto standard for objectively measuring physical activity is accelerometry, through devices such as the ActiGraph. However, commercially available accelerometers deliver manufacturer-dependent output values (counts) that are computed by obscure and proprietary signal processing techniques (van Hees et al, 2012) and only provide basic quantification of time averaged activity. It is evident that for a comprehensive analysis of both the level of a child's activity and the mechanics of motion that determine it, detailed quantitative measures are required across time scales (Mannini et al, 2013). This can be achieved by using automated signal analysis of millisecond resolution acceleration data to report on exercise 'quality' through gait analysis together with data integration across longer timescales (minutes to days) to assess the 'quantity' of activity, i.e. duration, variation and intensity, previously unreported in the literature. The aim of this study was to use a multi-time scale analysis to implement a novel approach to the profiling of activity and motion in children and to use this data for cluster based stratification of the cohort. Methods Eighty children (9-11y) volunteered to take part in this study and performed the 20m multistage fitness test (MSFT) whilst wearing a custom made, ankle worn Micro Electro Mechanical System (MEMS) device. Raw tri-axial acceleration traces from the device were used to derive various measures that describe both quantity and quality of motion. These included activity, duration and intensity, the spectral purity of the frequency content of the motion as well as key force characteristics of the gait trace. Results Preliminary data analysis confirmed that the quantity (5-20 minute profiles) and quality (50-500 ms profiles) characteristics were robustly and accurately assessed using the stored acceleration data. Profiling of the cohort using mean and coefficient of variation statistics for each of the quantifiers identified the stride to stride variability in the individual motion as well as the population heterogeneity that describes all of the children. Discussion Automated, quantitative profiling has allowed data from a cohort of children to be grouped together based on their similarity, enabling large amounts of data to be processed and allowing greater insight into both the quality and quantity of movement hitherto unavailable in the literature. References Mannini A, Intille S, Rosenberger M, Sabatini A, Haskell W. (2013). *Med Sci Sports Exerc*, 45, 2193-203 Van Hees V, Gorzelniak L, Leon E, Eder M, Pias M, Taherian S, Ekelund U, Renstrom F, Franks P, Horsch A, Brage S. (2012). *WoWMoM*, Montreal, QC, Canada, 1-6. Contact:C.CLARK.801344@swansea.ac.uk; C.BARNES.637351@swansea.ac.uk

#### CRITERION VALIDITY AND RELIABILITY OF REAL-TIME GPS FOR THE MEASUREMENT OF TEAM SPORT ACTIVITY

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Introduction Global positioning system (GPS) technology has become an increasingly utilised means of quantifying movement patterns and athletic workloads in elite team sports. Traditionally restricted by post-session (PS) download and analyses, commercial GPS systems now offer real-time (RT) monitoring capabilities. In combination with other integrated technologies (e.g. accelerometers and heart rate monitors), RT GPS technology provide immediate feedback that may be used to decisions relating to athletic performance. Despite widespread use, the validity and reliability of commercially available RT GPS systems remain unclear. This study aimed to examine the criterion validity of RT GPS against a known distance and to examine differences between RT and PS download GPS data during simulated team sport activity. Methods Three team sport athletes completed repetitions (n=300) of a 60s, 128.5m exercise circuit involving bouts of stationary, walking, jogging, running and sprinting activity designed to reflect the movement demands of team sports (Bishop et al., 2001). During exercise, participants wore a heart rate monitor and five 15Hz GPS units (SPI HPU, GPSports, Canberra, Australia) within a customised harness. A portable wireless transceiver was positioned within a clear 50m range of the participants to allow live GPS transmission. All data were recorded using the associated commercial software packages, with output settings for speed, distance, heart rate and impacts of the PS download software modified to match those provided by the RT software. Results Significant differences were observed between RT and PS download GPS measures for total distance, peak speed, mean heart rate and total impacts ( $P < 0.02$ ;  $d = 0.23-0.88$ ). Notably, RT and PS download GPS underreported a known distance by  $2.7 \pm 7.3\%$  and  $1.6 \pm 8.4\%$ , respectively. Although variation in total distance between the analysis methods were similar ( $CV = 5.80\%$  vs.  $5.76\%$ ), variability of distance in designated speed zones were higher

using real-time methods (<14.4km.h<sup>-1</sup>: CV=16.0% vs. 7.57%; >14.4km.h<sup>-1</sup>: CV=22.3% vs. 8.95%). Strong positive intraclass correlations were apparent between methods for measures of peak speed, heart rate and impacts ( $r=0.74-0.97$ ;  $P<0.05$ ). Discussion These data highlight marked differences in the measurement of simulated team sport activity between RT and PS download GPS analyses. While the measurement accuracy of RT GPS measures of total distance is acceptable, the variance in speed zone classifications in comparison with PS download analysis is high. Practitioners should be cautioned about using RT and PS download methods interchangeably and be aware of this error when monitoring GPS data live. References Bishop D, Spencer M, Duffield R, Lawrence S. (2001). *J Sci Med Sport*, 4(1), 19-29.

### **RUNNING ECONOMY CORRELATES WITH HORIZONTAL ACCELERATIONS OF THE HIP**

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**Introduction** A standardized method of comparing efficiency of running at different velocities is running economy (RE), measured as oxygen uptake per kg bodyweight in relation to running velocity. RE have been examined during treadmill and level path running showing considerable variation, app. ranging 170-240 ml O<sub>2</sub>/kg/km (1,2). Uniaxial accelerometry (vertical accelerations) is widely used for quantifying energy expenditure (EE) during activities of daily living. The accelerometer is most often positioned close to the body's center of mass, at the hip. While hip accelerometer counts correlate with EE at walking and very low running velocities < 10 km/h (3), counts do not to correlate with EE at low to high running velocities (4). The aim of this study was to investigate variation in RE during treadmill running using tri axial accelerometry. **Methods** Twelve male subjects, age 27.4 ± 8.5 yr, weight 69.8 ± 7.1 kg, height 178.7 ± 7.1 cm (mean ± SD) participated. All subjects were familiarized with treadmill running. Subjects performed six submaximal running velocities at 8.0, 10.0, 12.0, 14.0, 16.0 and 18.0 km/hr. Each exercise period was 4 min separated by 30 sec rest. Pulmonary VO<sub>2</sub> and VCO<sub>2</sub> were measured using Oxycon Pro (Jaeger, CareFusion). Accelerometer counts were measured at the subjects' right hip with triaxial accelerometers (GT3X, ActiGraph). **Results** Running economy at all sub-maximal velocities averaged 209.3±1.6 ml O<sub>2</sub>/kg/km (mean ± SE) and showed a curve linear relationship with increasing treadmill velocity ( $r=0.54$ ,  $p<0.001$ ) and an average optimum running economy of 202.3 ml O<sub>2</sub>/kg/km at 14.7 km/h. Accelerometer counts for all velocities averaged 8623±143, 3216±127 and 1293±103 counts pr. min (mean ± SE) in the vertical, horizontal and mediolateral axis, respectively. RE showed a significant linear correlation with hip horizontal acceleration counts ( $r=0.40$ ,  $p<0.001$ ). Higher counts were associated with superior RE. In contrast, vertical, mediolateral or vector magnitude counts were not correlated with RE. **Discussion** We report that high counts in horizontal hip accelerations are related to superior RE. Our data cannot entirely explain the variations observed in RE, although horizontal counts quantify accelerations occurring in the running direction. As high intensity interval training and strength training are known to improve RE (5), future investigations should therefore examine the effect of training interventions on hip accelerations in combination with leg accelerations. **References** 1. Franch et al. (1998). *Med. Sci. Sports. Exerc.* 30: 1250-125. 2. Jensen et al (1994). *Scand. J. Med. Sci. Sports.* 4: 234-238 3. Freedson, et al (1998). *Med. Sci. Sports Exerc.* 30: 777-781 4. Brage et al. (2003). *Med. Sci. Sports Exerc.* 35: 1447-1454 5. Barnes et al. (2015). *Sports Med* 45: 37-56 Contact jfranch@hst.aau.dk

### **CONCURRENT VALIDITY OF A FOOT MOUNTED IMU TO ESTIMATE STRIDE LENGTH IN RUNNING**

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**INTRODUCTION:** In recent years, several studies have tried to estimate stride length (SL) using body-mounted IMUs and reported promising results [1-4]. However, many studies have only focused on estimating SL for walking [3,4] and, to the best of our knowledge, no study has explicitly investigated the concurrent validity of a single foot-mounted IMU to estimate SL for running. Therefore, the purpose of this study was to determine whether a foot-mounted IMU could provide valid estimates for SL during distance running. It was hypothesized that SL as calculated by the sensor would display high to excellent levels of agreement with a 3D motion capture system criterion. **METHODS:** 11 young, healthy adults (4 female, 7 male) were recruited for this study. Participants were equipped with 3 reflective markers and a foot-mounted 9-DOF IMU (Xsens, MTw) on their right foot and subsequently performed 20 individual 10m runs in which they were tracked by a 6-camera 3D system (Vicon, T-Series). In order to identify the beginning and end of each trial, participants were asked to stand still for 5 sec before and after each run. A running-specific ZUPT-algorithm written in MATLAB was used to calculate SL with the IMU. **RESULTS:** A total of 331 strides were collected and included in the analysis. The analytical procedures successfully identified all of the steps that were recorded by the camera system. Statistical analysis revealed excellent levels of absolute agreement (ICC(3,1) = 0.955) between the two methods (Camera vs. IMU). The upper and lower bounds of the 95% confidence interval were 0.927 and 0.970, respectively. The mean absolute error of the sensor-based method was 1.8% (0.05m). **DISCUSSION:** The results show that SL for running can be accurately estimated with a single foot-mounted IMU in a controlled laboratory setting. However, it was noted that the accuracy varied between participants. It is likely that individual variations of running technique, such as foot strike patterns and ground contact time affect the accuracy of the sensor-based SL algorithm. Future research should focus on investigating whether similar accuracy can be achieved during prolonged overground running and for different populations and conditions. **REFERENCES:** [1] Angermann M, Robertson P, Kemptner T, Khider M (2010). *International Conference on Indoor Positioning and Indoor Navigation*, p.1-6. [2] Bichler S, Ogris G, Kremser V, Schwab F, Knott S, Baca A (2012). *Procedia Engineering*, 34, p.592-597. [3] Jimenez AR, Seco F, Prieto C, Guevara J (2009). *IEEE International Symposium on Intelligent Signal Processing*, p. 37-42. [4] Martin E. (2011). *IEEE Topical Conference on Biomedical Wireless Technologies, Networks, and Sensing Systems*, p. 79-82. Contact: markus.brahms@uregina.ca

### **QUANTIFICATION OF HIGH RUNNING VELOCITY USING A SOCCER MOTION CAMERA TRACING SYSTEM**

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**Introduction** Professional soccer clubs utilise semi-automated 'motion camera tracking systems' (MCTS) to track player's movements in competitive matches. This information is then used to inform the coaching process (Wright et al. 2014). The accuracy of MCTS have previously been validated using timing gate technology (TGT) (Di Salvo et al., 2006). This initial study demonstrated strong correlations of average speeds ( $r = 0.999$ ). However, the investigators did not measure total sprint distance or the number of entries into the 'sprint zone' (> 7m.s<sup>-1</sup>). Therefore, the aim of this study was to establish the accuracy of a widely used MCTS at detecting entries into the sprint zone. **Methods** Fourteen amateur soccer players were instructed to complete 4 maximal 30-meter sprints from a standing start (52 runs in total). Sprint speeds were recorded simultaneously using TGT (Brower timing Systems, Utah, USA) and a MCTS (Prozone @, Leeds, UK).

Timing gates were placed at 5m intervals across the running area from 10-30m. Each running time was recorded for further analysis. Results The MCTS recorded 39 entries into the 'sprint zone' and TGT recorded 22. A chi-square test was performed and no relationship was found between a confirmed sprint (TGT) and sprint detection by MCTS,  $X^2(1, N = 40) = .84, p = .58$ . The average Vpeak for TGT was  $7.11 \pm 0.68$  m.s<sup>-1</sup> ( $M \pm SD$ ) and  $8.04 \pm 0.63$  m.s<sup>-1</sup> for MCTS. Vpeak was moderately correlated between the 2 systems,  $r(40) = .63, p < .01$ . The total sprint distance recorded by MCTS was 553m but 109m was not confirmed by TGT. The average sprint distance from MCTS when not confirmed by TGT is  $7.77m \pm 3.41$ , and average TGT Vpeak  $5.05 \pm 0.36$  m.s<sup>-1</sup>. In contrast the average sprint distance from MCTS when confirmed by TG is  $18.5m \pm 8.58$ , and average TGT Vpeak  $6.02 \pm 0.59$  m.s<sup>-1</sup>. Discussion The results suggest that this MCTS is not accurate at detecting high velocity movements. Considering that movement at higher speeds may influence the recovery process following competition (Nedelec et al. 2014) this observation may have implications for applied practitioners who prescribe recovery protocols following match-play. Further research is required to validate the findings from this study using a larger sample size. References: Di Salvo et al. (2006) Validation of Prozone: a new video-based performance analysis system. *Int J Perform Analysis Sport Jun*; 6 (1): 108-19 Wright et al. (2014) The wider context of performance analysis and its application in the football coaching process *Int J Perform Analysis Sport Dec*; 14 (3) 709-733 Nedelec et al. (2014) The influence of soccer playing actions on the recovery kinetics after a soccer match. *JSCR* 28 (6) 1517-1523

### A NOVEL WIRELESS ELECTRONIC DEVICE TO DIRECTLY MONITOR TV VIEWING TIME

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Television (TV) viewing time is the most predominant sedentary behavior and associates with a number of cardiovascular risk factors such as the metabolic syndrome, obesity, and abnormal glucose metabolism. Few measurement tools, such as direct observation and videotaping, have been utilized to objectively monitor TV viewing time. Unfortunately, these measurements have shortcomings as they invade the personal privacy and are impractical in large-scale research studies. Thus, there is a need for alternative objective measures. The main aim of this study was to design an electronic device to objectively monitor TV viewing time in children. Eight children (mean  $\pm$  SD, age,  $10.7 \pm 2.1$  years; body mass,  $35.7 \pm 17$  kg; height,  $137.4 \pm 12.3$  cm) participated in this study. TV viewing time was directly measured for two consecutive days by a novel wireless electronic device, using Radio-frequency identification (RFID) technology which is connected to a main electronic board that is designed to measure TV viewing time in minutes. The preliminary results show that the average TV viewing time of children was  $99 \pm 75$  min/day. It is concluded that the current research is expected to produce a novel wireless electronic tool that can monitor TV viewing without intrusion to the personal privacy and can be widely used as an objective method of assessing TV viewing time.

### VALIDITY OF THE WAHOO KICKR POWER TRAINER AND RELIABILITY OF A 4 KM CYCLE TIME TRIAL

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Purpose: To assess the validity of power output of the Wahoo KICKR Power Trainer using a dynamic calibration rig and the reliability of a 4 km cycle time trial (TT) when completed on the Wahoo KICKR Power Trainer. Methods: The Wahoo KICKR power output was compared to a dynamic calibration rig over power outputs of 100-600 W at cadences of 80, 90 and 100 rpm. To assess the reliability of a 4 km TT, twelve trained male cyclists (mean  $\pm$  SD; age:  $34.0 \pm 6.5$  years, height:  $178.4 \pm 6.2$  cm, body mass:  $76.8 \pm 9.6$  kg) completed three 4 km TTs on the Wahoo KICKR Power Trainer, each separated by a minimum of two and a maximum of three days. Mean power (W), cadence (rpm:  $n = 11$ ), speed (km.h<sup>-1</sup>), heart rate (bpm) and total time (s) were recorded for each TT while ratings of effort (0-10) were collected immediately upon TT completion with sessional ratings of perceived exertion (6-20) collected 10 mins post each TT. Results: Bland - Altman analysis demonstrated a bias of -0.8% (95% Limits of Agreement: -5.6 - 4.0%) across all three cadences for the Wahoo KICKR Power Trainer when compared with the dynamic calibration rig. Intraclass correlation (ICC) determined reliability with the average ICCs between TTs (2 to 1, 3 to 2 and 3 to 1) nearly perfect for power 0.95 (95%CI 0.89-0.98) and heart rate 0.93 (95%CI 0.85- 0.98) while the ICC was moderate for speed 0.70 (95%CI 0.46- 0.88) and total time 0.75 (95%CI 0.53-0.90) with a high ICC for cadence 0.80 (95 %CI 0.60- 0.92). Coefficient of variation was 2.9%, 4.5%, 3.7%, 1.5% and 3.6% for power, cadence, speed, heart rate and total time, respectively. Conclusion: When compared to a dynamic calibration rig, the Wahoo KICKR Power Trainer displays a small mean bias across power outputs of 100-600 W. When completed on the Wahoo KICKR Power Trainer, a 4 km TT in trained cyclists is highly reproducible for power with a sensitivity to detect a smallest worthwhile change in power output of 1.5%.

## Mini-Orals

### MO-PM34 Neuromuscular Physiology: Coordination

#### BILATERAL DEFICIT: CONTRIBUTION OF POSTURAL ADJUSTMENTS TO TORQUE PRODUCTION

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Introduction During maximal contractions, the sum of forces exerted by homonymous muscles unilaterally is typically higher than the sum of forces exerted by the same muscles bilaterally. However, the underlying mechanism(s) of this phenomenon, which is known as the bilateral deficit, remain equivocal (Jakobi & Chilibeck 2001). One potential factor that has received minimal attention is the contribution of postural muscles and positional adjustments to bilateral and unilateral force production. The purpose of this study was to evaluate the plantar-flexors in one common position in an innovative ergometer that permitted the influence of torque from postural adjustments to be adapted. Methods Twenty healthy adult males performed unilateral and bilateral maximal voluntary isometric plantar-flexion contractions. Torques at the ankles were assessed with a custom designed ergometer that allowed the participant to be identically positioned between setups where torque generated from postural adjustments were included within the net ankle torque (locked-unit) or independent of the ankle (open-unit). Electromyographic activity was recorded from the soleus, gastrocnemius medialis, gastrocnemius lateralis and tibialis anterior muscles of both legs. Results While there was a significant bilateral deficit in the locked-unit ( $p=0.01$ ), it was not evident in the open-unit ( $p=0.07$ ). In the locked-unit, unilateral torque was greater than in the open-unit ( $p<0.001$ ) and this was due to an

additional torque from the body since the electromyographic activity of the agonist muscles did not differ between the two setups ( $p>0.05$ ). Discussion This study revealed that postural adjustments directly influence isometric torque production in unilateral and bilateral contractions and this contributes to observations of the bilateral deficit. The present data demonstrated that postural adjustments contribute substantially to torque and that when these adjustments are contained within a measure of plantar-flexion the bilateral deficit is recorded. However, when force is localized to the ankle joint bilateral and unilateral forces were similar. The vast majority of the literature on the bilateral deficit has clearly speculated and attempted to study a neural phenomenon. These data indicate that further exploration into the bilateral deficit needs to account for postural adjustments in the measurements of torque. References Jakobi JM, Chilibeck PD. (2001). *Can J Appl Physiol*, 26, 12–33. Contact emilie.simoneau@univ-valenciennes.fr

### INVESTIGATION OF MOTOR UNIT SHORT-TERM SYNCHRONIZATION IN STERNOCLEIDOMASTOID MUSCLES

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Motor units are the fundamentally functional units of the neuromuscular systems, the recruitment or derecruitment of the motor units and the pattern of the discharge rates of the active motor units have been proven to modulate the forced production of the neuromuscular systems (1). Along with these basic electrophysiological properties, the motor unit short-term synchronization, which stands for an above-chance tendency for near-simultaneous discharges between pairs of motor units, also plays a pivotal role in regulating the mechanical output of the neuromuscular systems (2). This study, aimed to investigate the properties of the motor unit short-term synchronization to characterize the neuromuscular control strategies in the sternocleidomastoid muscles for healthy individuals. The surface electrophysiological signals of the bilateral sternal heads of the sternocleidomastoid muscles were detected at 25% of the maximum voluntary contraction during cervical isometric flexion in twelve healthy individuals (mean age:  $27.5\pm 6.2$  years) and then decomposed into individual motor unit action potential trains. Subsequently, the strength of the short-term synchronization index (Sync Index) of each motor units pair were determined by computing the percentage of the significantly synchronous firings occurring within  $\pm 6$ ms of zero time latency normalized to the number of firing instances of the reference motor unit. In the results, a total of 479 motor units and 2,193 motor units pairs was identified and averages of 1.52%, 3.14%, 3.78%, 4.68%, 6.63% and 5.40% of all the firings were short-term synchronized for all identified motor units pairs with mean recruitment thresholds of 0%~5%, 5%~10%, 10%~15%, 15%~20%, 20%~25% and more than 25% MVC, respectively. Significant dependence of short-term synchronization on the mean recruitment threshold in each identified motor units pair was documented in healthy individuals ( $\text{Sync Index} = 0.17 * \text{Threshold} + 1.60$ ,  $R^2 = 0.811$ ,  $p < 0.01$ ). These present results agreed with previous observations of greater strength of short-term synchronization for the motor units pairs with high-mean recruitment thresholds as compared to those with low-mean recruitment thresholds (3, 4). It is concluded that motor unit short-term synchronization serves as a deliberate strategy for neuromuscular activation attempting to produce efficient mechanical output of the sternocleidomastoid muscles in healthy individuals. 1. Binder MD, and Mendell LM. (1990) New York: Oxford University Press, 397. 2. Semmler JG. (2002) *Exercise and sport sciences reviews* 30: 8-14. 3. Defreitas JM, Beck TW, Ye X, and Stock MS. (2014) *Muscle & nerve* 49: 575-583. 4. Schmied A, Vedel JP, and Pagni S. (1994) *The Journal of physiology* 480 ( Pt 2): 369-387.

### REACTION TIME IN UPPER EXTREMITIES FOLLOW A PROXIMAL-DISTAL GRADIENT THAT MIGHT BE LINKED TO NEUROPHYSIOLOGICAL DIFFERENCES

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Introduction Reaction time (RT) is the interval between presentation of a stimulus and the response to it (Oxedine, 1968; Schmidt & Lee, 2014), and a short RT is important for coping with challenging events and perturbations in everyday life. RT depends on properties of the neuromuscular system (Guyton & Hall, 2011). The neuromuscular system for proximal and distal effectors have several neurophysiological differences that might influence RT. Such differences is documented for the corticospinal pathways, number of synapses, latency time, size and length of axons from motor cortex to the innervated muscles and nerve conduction velocity (Bear, Connors & Paradiso, 2006; Brodal, 2004; Kolb & Wishaw, 2009). Based on these morphological differences the purpose of this study was to explore eventually functional differences in RT for effectors in the upper extremities. Method 12 sport science students were recruited to perform a simple RT-task. The subjects had to press a button as quickly as possible after a presentation of a light stimulus. The task consisted of a constrained single joint isometric contraction (pressing the button) by randomized single-joint extension of shoulder, elbow, wrist and index finger. Results The results showed a proximal-distal gradient in RT with a significant joint effect for shoulder, elbow, wrist and index finger. Shoulder had the lowest RT (mean  $22.699\text{ms} \pm 1.753$ ), followed by elbow (mean  $23.811\text{ms} \pm 1.756$ ), wrist (mean  $24.704\text{ms} \pm 3.412$ ) and index finger (mean  $30.256\text{ms} \pm 3.907$ ). Discussion The observed proximal-distal gradient in RT for upper extremities favored proximal compared to distal effectors. The relatively low RT for proximal effectors might be explained by higher nerve conduction speed because of big sized axons and higher action potential frequency in addition to shorter neural pathway from M1 to the activated muscles. This in spite of distal effectors monosynaptic projections, lower latency time and lower threshold for action potentials. In conclusion, the neurophysiological differences between for proximal and distal joints in sum cause a proximal-to-distal gradient for RT. References Bear, MF., Connors, BW., Paradiso. MA. (2006). *Neuroscience: exploring the brain*. Third edition. United states of America: Hearthsides Publishing Services Brodal, P. (2004). *The central nervous system: structure and function*. Oxford: Oxford University Press. Guyton, AC. & Hall, PE (2011). *Textbook of medical physiology*. (12th ed.) Philadelphia, PA: Saunders/Elsevier. Oxedine, JB. (1968). *Psychology of motor learning*. New York: Meredith Corp. Schmidt, RA. & Lee, TD. (2014). *Motor learning and performance: from principles to application*. Fifth edition. United States of America: Courier Companies. Inc.

### CORTICOSPINAL EXCITABILITY AND INTERHEMISPHERIC INHIBITION

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CORTICOSPINAL EXCITABILITY AND INTERHEMISPHERIC INHIBITION ASSOCIATED WITH WIDE-PULSE HIGH-FREQUENCY NEUROMUSCULAR STIMULATIONS Nicolas Gueugneau, Sidney Grosprêtre, Romuald Lepers INSERM-U1093 (Dijon, France) ngueugneau@netcourrier.com INTRODUCTION Neuromuscular electrical stimulations (NMES) with wide-pulse-high-frequency (WPHF) induce muscle contractions partly originating from a central pathway (1). Yet, while this type of NMES is known to modulate spinal excitability, the precise contribution of supraspinal circuits of motor control remains to be determined (2). Here, we aimed at evaluating the effect of an acute upper-arm WPHF

NMES training on both spinal and cortical excitability. Particularly, we evaluated spinal excitability (through H-wave), and cortical and transcallosal excitability, as assessed by motor evoked potentials (MEPs) and interhemispheric inhibition (IHI) respectively. METHOD Ten healthy subjects underwent a single WPHF NMES session consisting of 60 stimulation trains (100Hz with 1ms pulse width evoking 15% of MVC, 5s on / 5s off) of the right Flexor Carpi Radialis (FCR). The following parameters were recorded from the right and left FCR before and after the NMES protocol: MVC torque (wrist flexion), H reflex (Hs), M wave (Ms), MEPs amplitudes, and IHI from right to left motor cortex. Wrist force (torque time integral), right and left Hs were also monitored throughout the protocol. RESULTS The NMES session did not produce any significant change of the MVC, Ms and MEPs bilaterally ( $P > 0.05$ ). However, right Hs/Ms was strongly decreased (-50%,  $P < 0.05$ ) and right to left IHI was significantly increased (+15%,  $P < 0.05$ ) after the protocol. Interestingly, online monitoring of the wrist force and Hs of the right FCR shown that they abruptly drop after the very first contractions (-40%, of their pre-test values during the 5 first contractions) and then slowly decreased until reach their post-test values. DISCUSSION We showed that an acute session of WPHF NMES applied to the right upper limb did not produce any change of the MVC. However, spinal excitability was strongly decreased during the protocol as we shown an abrupt drop of the right Hs. Interestingly, while cortical excitability was not significantly modulated, it seem that the NMES session had an influence on transcallosal excitability, as we showed an increased of IHI after the protocol (to a comparable extent to what is observed after voluntary contractions (3)). It can be concluded that WPHF NMES involve mechanisms located at spinal and supraspinal levels. REFERENCES (1) Collins DF & al., *J Physiol* 2002; 538: 289–301. (2) Lagerquist O & al., *Exp Brain Res* 2012; 222: 41-53. (3) Avanzino & al., *European J Neurosc* 2014; 40: 2581–2588

### DIFFERENCE BETWEEN MECHANOMYOGRAPHIC AND ELECTROMYOGRAPHIC RESPONSES TO ISOMETRIC CONTRACTIONS OF BICEPS BRACHII AT DIFFERENT ELBOW JOINT ANGLES

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Introduction A previous study reported that biceps brachii electromyogram (EMG) amplitude linearly increased with increasing in contraction intensity, but this was not the case for mechnomyogram (MMG) [1]. The amplitude of MMG represents low-frequency oscillations of active muscle fibres [2], thus MMG may be affected by muscle stiffness that is determined by the number of attached cross-bridges. It was hypothesised that EMG would not be affected by muscle length changes, but MMG would be. The present study investigated the effect of muscle length modulated by the elbow joint angle on MMG and EMG of biceps brachii during isometric contractions at different intensities. Methods Fifteen men (24-33y) performed isometric contractions of the elbow flexors at 15, 30, 45, 60 75, and 90% of their maximal voluntary contraction (MVC) strength at the elbow joint angle of 90°, 60° and 30° (0°=full extension), in this order. Surface bipolar EMG electrodes were placed at the mid-belly of the biceps brachii, and an accelerometer to record MMG was placed in between the electrodes. Torque, MMG, and EMG signals were recorded to a computer at a sampling rate of 2 kHz, and root-mean-square (RMS) of the MMG and EMG signals was calculated for 0.5 s when the target force was achieved, and normalised by RMS during MVC. A two-way repeated-measures ANOVA was used to compare between MMG and EMG for changes in RMS amplitude over the intensities for each joint angle. When a significant main or interaction effect was found, a Tukey post-hoc test was followed. Results MVC strength was greater ( $P < 0.05$ ) at 90° followed by 60° (87% of that at 90°) then 30° (68%). For all elbow joint angles, RMS of EMG linearly increased with increasing the intensity from 15% to 75% (30°, 60°) or 90% (90°), and no significant difference was found for the magnitude of the change between the angles. RMS of MMG at 90° also linearly increased with increasing the intensity from 15% to 90% ( $P < 0.05$ ) in a similar way to that of EMG. However, at 60° and 30° the increases in RMS were greater for MMG than EMG ( $P < 0.05$ ) from 30% to 60%, but no further increases in MMG were evident after 60% MVC at 60° and 45% MVC at 30°. Discussion These results supported the hypothesis, showing that muscle length change did not affect EMG but affected MMG. It may be that no further increases in RMS of MMG after the moderate intensity at 30° and 60° indicate no further increases in muscle fibre oscillations, because of longer muscle fibre length at these angles than 90°. References 1) Orizio et al. (2003) *Eur J Appl Physiol* 90:326-36. 2) Barry (1987) *Biophys J* 51:769-73.

### SHORT-TERM LOW-LOAD BLOOD FLOW RESTRICTED EXERCISE IMPROVES MECHANICAL MUSCLE FUNCTION AND NEUROMUSCULAR ACTIVATION

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Introduction In the last decade low load blood flow restricted (BFR) exercise has been established as a low load alternative to increase maximal muscle strength (MVC) and muscle mass in human subjects (Kubo et al. 2006; Nielsen et al. 2012). Recently, we showed a marked rapid increase in myofiber cross sectional area (CSA) after 5 days of BFR training (Nielsen et al. 2012). However, it remains unknown if such early increase in myofiber CSA is translated into functional strength gains or mainly reflects transient cellular fluid accumulation. Therefore, the aim of this study was to investigate whether short-term (5 days) BFR exercise intervention leads to enhanced mechanical skeletal muscle function. Methods Ten healthy male subjects performed 5 consecutive days (7 sessions) of knee extension exercise with partial blood flow restriction. Four sets of unilateral knee extensions were performed to concentric failure using low muscle loadings (20% 1RM). Lower limb blood flow restriction was achieved using a pneumatic cuff (Zimmer, US) inflated to 100 mmHg, which was released upon cessation of the fourth set. Mechanical muscle function and neuromuscular activation were evaluated before and after the 5-days intervention period using maximal isometric knee extensor dynamometry (MVC) and interpolated twitch analysis, respectively. Results MVC increased 3.0% from Pre ( $324.6 \pm 69.9$  Nm) to Post intervention ( $334.6 \pm 59.1$  Nm) ( $P < 0.05$ ) ( $P < 0.05$ ). Similarly, neuromuscular activation increased 1.8% from Pre ( $94.4 \pm 2.5$  %) to Post ( $96.1 \pm 1.9$  %) ( $P < 0.05$ ). Discussion In the present study MVC increased (~3 %) after just 5 days (7 sessions) of low-load BFR exercise, which was accompanied by comparable gains in neuromuscular activation (~2 %). Thus, the marked increases in myofiber CSA (~38 %) previously observed using a similar time course and exercise regime (Nielsen et al. 2012) might be accompanied by quantitative and/or qualitative gains in contractile acto-myosin properties, although the present increase in MVC could also be related to increased neuromuscular activation. In contrast, neuromuscular activation remained unchanged after 12 weeks of BFR training (Kubo et al. 2006), while no previous study has reported detectable neural adaptations with BFR exercise. These divergent observations may be related to differences in training protocols, as repetitions were performed to failure in the present study (vs. using a preset number of repetitions), potentially resulting in sEMG values  $\geq 100$  % of maximal isometric sEMG (Wernbom et al. 2006) that may represent a significant stimulus for neural adaptation. References Kubo K, Komuro T, Ishiguro N, Tsunoda N, Sato Y, Ishii N, Kanehisa H, Fukunaga T. (2006). *J Appl Biomech* 22, 112-119. Nielsen, J.L., Aagaard, P., Bech, R.D., Nygaard, T., Hvid, L.G., Wernbom, M., Suetta, C., Frandsen U. (2012). *J Physiol*, 590 (Pt 17), 4351-61. Wernbom M, Augustsson J., Thomeé R. (2006). *J Strength Cond Res* 20(2), 372-377. Contact jakobnielsen@health.sdu.dk

### NEUROMUSCULAR RESPONSE OF THE LOWER LIMB DURING GROSS MOTOR TASKS

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1. School of Sport, Exercise and Health Sciences, Loughborough University, United Kingdom 2. Institute for Sports Research, Nanyang Technological University, Singapore, 3. National Institute of Education, Nanyang Technological University, Singapore. **INTRODUCTION:** Neuromuscular (NM) response during simple reaction time tasks requiring co ordination of large muscles is less well understood than during simple tasks with small muscles. In athletic actions the former are required and given the marked differences in the neuromuscular system between the two scenarios differences in reaction time between them may be meaningful. The aim of this study was to investigate temporal characteristics of the lower limb NM response during weight-bearing (WB) and non-weight-bearing (NWB) simple reaction kicking and plantarflexion tasks. **METHODS:** Following ethical approval, 16 healthy males ( $23.5 \pm 1.0$  years) performed 10 trials of plantarflexion and kicking as quickly as possible following visual stimulus from WB and NWB start positions. Wireless surface EMG electrodes with tri-axial accelerometers (2000 Hz, Trigno, Delsys Inc., Natick, MA., USA) were attached to biceps femoris, rectus femoris, vastus lateralis and medialis, gastrocnemius lateralis and medialis and tibialis anterior of the preferred kicking leg. Time difference between onset of stimulus and initiation of first muscle activation (pre-motor time, PMT), initiation of primary agonist muscle (PA) and initial acceleration (movement time, MT) were determined for each trial. Between-task and between-condition differences were determined using paired t-tests (statistical significance:  $p < 0.05$ ) and Cohen's Dz (moderate effect  $> 0.6$ , large effect  $> 1.2$ ). **RESULTS:** Average PMT, PA and MT were 171, 197 and 224 ms (NWB kicking), 163, 255 and 255 ms (WB kicking), 188, 197 and 229 (NWB PF) and 192, 242 and 254 (WB PF). All differences were moderate/large. Differences between WB and NWB PA during kicking (197 vs. 255 ms) and plantarflexion (197 vs. 242 ms), and PMT in WB kicking and plantarflexion (163 vs. 192 ms) were statistically significant. Muscle used to determine PMT varied with subject, task and condition but gastrocnemius medialis was used most frequently across all trials. **DISCUSSION:** Increased PMT during WB plantarflexion compared to kicking may be due to preferential selection of muscles for initial stabilisation with longer response times, in particular the antagonistic tibialis anterior. Increased PMT is associated with decreased ability to respond to perturbation. A need for stabilisation prior to completion of WB test tasks may explain shorter PA during NWB tasks. Results support the large capacity and individual nature of neuromuscular system adaptation to altered task demands, but further work is required to fully investigate these capacities. **CONTACT:** L.A.M.Furlong@lboro.ac.uk

### SPECTRAL EMG CHANGES OF THE SUPERIMPOSED M WAVE DURING ISOMETRIC VOLUNTARY CONTRACTIONS OF INCREASING INTENSITY

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**Objective:** We examined the power spectral changes of the compound muscle action potential (M wave) evoked during isometric contractions of increasing strength. **Methods:** Surface electromyography (sEMG) of the vastus lateralis and medialis was recorded from 20 volunteers who performed 4-s step-wise isometric contractions of different intensities. A maximal M wave was elicited by a single stimulus to the femoral nerve and superimposed on the voluntary contractions. The spectral characteristics ( $F_{mean}$  and  $F_{median}$ ) of sEMG and M-wave signals were calculated. **Results:** M-wave spectral indicators increased systematically with contraction intensity up to 60% MVC, and then levelled off at higher forces. Over the 10-60% MVC range, the increase in spectral indicators was 3 times higher for M waves (36%) than for sEMG (12%). **Conclusions:** The consistent increase in M-wave spectral characteristics with force is due to the fact that the number of motor units recruited by the superimposed supramaximal stimulus is approximately stable.

### EFFECT OF WEIGHT BEARING ON TOE FLEXOR STRENGTH AND FOOT ARCH HEIGHT

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**[Introduction]** Toe flexor strength (TFS) is associated with the cross-sectional area of foot intrinsic muscles (Kurihara et al., 2014) and physical performances of the lower limbs in children (Morita et al., 2015) and adolescents (Otsuka et al., in press), but not with the foot arch height (FAH; Morita et al., 2015). Kelly et al. (2014) shows that with increasing load perpendicular on the foot, FAH decreases and activities of electromyography of the intrinsic foot muscles increase; however, it is still unclear whether changes in FAH with increasing loading affect TFS. The aims of this study were to investigate the effects of weight bearing on TFS and how changes in FAH were related to TFS. **[Methods]** Twelve healthy college-students participated, and their TFS and FAH were measured with 5 weight bearing conditions (0, 20, 40, 60, and 80 kg) in the sitting position. Weight plates were borne on the distal end of thigh and the vertical ground reaction force on the foot was recorded during TFS measuring. FAH was assessed as distance between the navicular tuberosity of the foot and the floor. **[Results]** TFS increased with increasing load, while FAH lowered with increasing load. There were significant correlations between changes of TFS and changes of FAH after weight bearing ( $r = -0.333$ ,  $p < 0.05$ ). **[Conclusion]** Our results suggest that weight bearing on the foot could enhance TFS that might be due to the decrease in the foot arch height with the stretching of the plantar muscles. **References:** Morita N, Yamauchi J, Kurihara T, Fukuoka R, Otsuka M, Okuda T, Ishizawa N, Nakajima T, Nakamichi R, Matsuno S, Kamiie S, Shide N, Kambayashi I, Shinkaiya H. Toe flexor strength and foot arch height in children. *Med Sci Sports Exerc.* 2015; 47: 350-6. Otsuka M, Yamauchi J, Kurihara T, Morita N and Isaka T. Toe flexor strength and lower-limb physical performance in adolescent. *Gazzetta Medica Italiana Archivio per le Scienze Mediche.* in press. Kurihara T, Yamauchi J, Otsuka M, Tottori N, Hashimoto T, Isaka T. Maximum toe flexor muscle strength and quantitative analysis of human plantar intrinsic and extrinsic muscles by a magnetic resonance imaging technique. *J Foot Ankle Res.* 2014; 7: 26. Kelly LA, Cresswell AG, Racinais S, Whiteley R, Lichtwark G. Intrinsic foot muscles have the capacity to control deformation of the longitudinal arch. *J R Soc Interface.* 2014; 11: 20131188.

## Mini-Orals

### MO-SH11 Sports statistics & Analysis II

#### COMPARATIVE OF RACE STRATEGIES VERSUS OPTIMAL STRATEGIES IN 2000 M ROWING

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**Introduction** To be successful in rowing competition need a good strategy. Pacing strategic is one of a key factor for rowing competition. It is influencing in energy expenditure and the development of fatigue. Therefore, the aim of this study was to compare optimal strategy with race strategies of Thailand women double scull team. **Methods** A numerical program of rowing has been developed to simulate and optimization rowing strategy which relates the energy production and spent during the race. The simulations in this study are performed by solving equations of motion. The forces acting on the rower and boat are considered. By vary the power output will result in fastest strategy. Then the optimal strategy profile were compared with the race profile. **Results** The results are clearly showing that optimal pacing strategies are more beneficial to performance than race strategy. Optimal strategy achieved better finishing times than race strategy. It have lower variation of boat speed during the race. **Discussion** The studies in this paper has demonstrated the influence of pacing strategy on performance. It is suggested that psychological factors influenced for decision making by rowers in competitive event. They believe that when they leading the race from the start it is easier to control the race and get some psychological advantage. However it is not an idea for good energy expenditure and developing of fatigue. The results of this study are significance to rowers, coaches and sport scientists, for training and racing. **References** Muehlbauer T, Schindler T, Widmer A. (2010) *Eur J Sport Sci*, 5, 291–296. Garland SW. (2005) *Br J Sports Med*, 39, 39–42. Contact rachnavy@sut.ac.th sert authors here

#### STRUCTURAL EQUATION MODELS OF MORPHOLOGICAL SPRINT MOTION FOR ELEMENTARY SCHOOL CHILDREN

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The purpose of this study was to establish morphological models of the sprint in order to develop some effective methods for teaching the sprint in the physical education class. **Methods** The two types morphological models of the sprint motion, circular model and infinity model, were drawn applying cause and effect diagram or fishbone diagram, one of the quality control tools. These models were covered the descriptive checkpoints of previous studies. The circular model composed 3 major motions; ground catching, driving, and swing action. The infinity models were composed ground catching, scissors and release, on which scissors positioned center and other 2 motions formed infinity shape. These motions were constructed 36 morphological observation points. Every morphological observation was categorized into 2-3 levels respectively. Intermediate sprint forms (25-35m of 50m sprint) of 189 3rd and 4th-grade elementary school children were recorded by digital video cameras. Their forms were played in slow motion or frame-by-frame, and an investigator evaluated the checkpoints. **Structural equation modeling (SEM)** was applied for both circular and infinity models based on the two hypothesized causal models. **Results and Discussion** The major motions of sprint of both circular and infinity models were constructed from 5 motions: swing of free leg, the catching preparation, ground-catching motion, drive motion and push motion including 13 checkpoints. The circular model was better than infinity models; the fitting indices were chi-square=114.91 (df=98,  $P<0.05$ ), RMR=0.044, GFI=0.906, AGFI=0.856 and RMSEA=0.070 on the circular model, and chi-square=140.75(df=59,  $P<0.05$ ), RMR=0.039, GFI=0.885 AGFI=0.822 and RMSEA=0.086 on the infinity model. The model was easy to understand the casual relationship of time-followed sprint motions. The viewpoints related to scissors motion should be developed because the motion on the infinity model was assumed the one of the important concept for sprint motion. Arm pumping action and 10-meter running time were added on the circle model: the fitting indices were chi-square=170.93 (df=26,  $P>0.05$ ), RMR=0.064, GFI=0.886, AGFI=0.842 and RMSEA=0.063. The arm pumping action was only affected to ground-catching motion. The other arm motions such as arm front position or back position and body axis construction motion were not contributed to the final model. The drive motion strongly influenced running time (causal coefficient = -0.88). **Conclusions** Sprint motion was able to evaluate with circular model of leg motions. The model. **Criterion-related validity** was investigated on the circular model. This work was supported by Grant-in-Aid for Scientific Research(C), (24500697) Japan. E-mail skokudo@dolphin.kobe-u.ac.jp

#### SWIMMER TRACKING BY SINGLE HIGH-DEFINITION CAMERA

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**INTRODUCTION** Zoom video of Swimmers is useful for coaching and reviewing. Location of a swimmer along a swimming lane is necessary to produce his/her zoom video automatically. There are some approaches to estimate location of a swimmer by setting multiple cameras with computer vision method on a pool such as [1], but these approaches are not practically available in regular pools. We propose swimmer tracking method that utilizes single 4K camera with a resolution of 3840 pixels by 2160 pixels. **METHOD** We assume the camera is set at the higher position in audience seats so that it can cover whole water surface of the pool. Our proposed procedure has four steps; lens distortion correction, rectification of the pool area, extraction of swimmer region, and model fitting to finally estimate the position of a swimmer. First two steps are implemented by geometric operation in computer vision approach[2]. A rectangular shape region that corresponds to one lane is passed to the extraction step of swimmer region. Background subtractor[3] is applied to detect swimmer region. Detected region is integrated along the vertical axis of the swimming lane. As a result, image feature function  $f(p, t)$  is obtained where  $p$  is the distance along the swimming path from the start, and  $t$  is the time with resolution of frame per second. We prepare a swimmer model  $s(p)$  that describes the distribution of image feature over swimming path direction. By searching the most fitted position  $p$  with the model  $s(p)$  over  $f(p,t)$  at time  $t$ , we obtain the swimmer location  $p$  at time  $t$ . **RESULTS AND DISCUSSION** We have applied the proposed method for a real swimming game to verify the performance. Reference location of swimmers was manually given by checking the original 4K video. We have verified the performance of the proposed method for surface swimming section because our current swimmer model  $s(p)$  is designed to describe swimming actions near water surface. Underwater section and turn section are left for our future work. The averaged errors of location estimation for surface section are; breaststroke:20cm, backstroke:20cm, freestyle:50cm, butterfly:30cm. Note that we eliminated a section where strong disturbance from large video screen could be found. **REFERENCE** [1] E. Pogalin et al, "Video-based Training Registration for Swimmers. *Int. J. Computer Science in Sport*, vol.6, ed.1, pp.4-17, 2007. [2]



Y. Kameda et al. "Digital Zoom Video of Swimmers by High-Definition Camera," ECCS 2015, to appear. [3] P. KaewTraKulPong et al, "An Improved Adaptive Background Mixture Model for Real-time Tracking with Shadow Detection," 2nd European Workshop Advanced Video Based Surveillance Systems, AVBS01, 2001. CONTACT s1420828@u.tsukuba.ac.jp, kameda@iit.tsukuba.ac.jp

### SUCCESS IN ELITE JUNIOR TENNIS: THE SHORT STORY

Klaus, A.1, Bradshaw, R.3, Young, W.3, O'Brien, B.3, Zois, J.2

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Introduction Point duration in competitive tennis is becoming shorter thus placing a greater emphasis on the first strokes of each point. Therefore, the aim of this study was to analyse the point profile of short rallies in elite junior tennis. Methods We investigated stroke type, point outcome and stroke position during ten randomly selected sets of competition (State Championships on hard court). All participants (n=8) were right handed and male tennis player of the age group 14 and under. Descriptive measures included the general point profile considering performance of the first three strokes of each point: service, return-of-serve (return) and first groundstroke of the service player (first-shot). Results Almost half of all rallies (49.0%), which are characterized by a short duration (5.81 sec SD  $\pm$  6.41), completed concluding 1-3 strokes (overall mean: 4.8 strokes per rally; SD  $\pm$ 3.7; median: 4) as a consequence of an error (82.8% compared to 17.2% winners;  $p < 0.001$ ). A large percentage of errors were made via the return and first-shot (44.8% and 38.0%;  $p < 0.001$ , respectively). In comparison to net game specific stroke types (e.g. volley; 3.5%) a more frequent utilization of groundstrokes (33.4%), and service and return (40.7%) was observed. The performance of the first-serve is characterized by an 'in-percentage' of 54.6% and an improved chance of winning the point (for the server) following a 1st serve (55.9%;  $p < 0.001$ ) compared to a 2nd serve (49.9%). The 2nd serve return was reliant on the forehand compared to backhand return (65.7%;  $p < 0.001$ ), as was the first-shot to forehand groundstroke compared to other strokes (56.8%;  $p < 0.001$ ). The majority of stroke positions for first-shot winners were located in the central zone of the court (52.2%;  $p < 0.01$ ). Discussion Contrasting to professional tennis players, juniors produce more 1st serve errors and win fewer points directly via the serve. Success in junior tennis relies in minimizing errors within short rallies specifically on the return and first-shot of the server. Developing a court position which enables optimal use of the forehand groundstroke following the 1st serve also seems to be of high tactical importance. Coaches of elite junior tennis players should focus on strategies to optimize court position following the serve, and service/return percentage within short rallies to optimize success rate in junior tennis. To achieve this, the server should utilize the serve as a 'set-up' tool, dictating the direction of the returners return of serve within the central zones of the court. Additionally, short point duration and less number of strokes underline the demand for game-specific physical and tactical practice for junior tennis player. Contact [anneklaus42@gmail.com](mailto:anneklaus42@gmail.com)

### DIGITAL ZOOM VIDEO OF SWIMMERS BY HIGH-DEFINITION CAMERA

Kameda, Y., Kitahara, I., Ohta, Y., Yoshimi, J., Ishikura, K., Takagi, H.

University of Tsukuba

INTRODUCTION Swimming video in fine resolution could be helpful for swimmers to review their races. However, conventional manual tracking by a zoom camera on a tripod can produce only one video for single swimmer at a time. We propose a new video production approach that can produce multiple zoom videos for each swimmer in a race. 4K camera with the resolution of 3840 pixels by 2160 pixels is used for capturing source video. Note that a swimmer registration method is also developed for this approach but it is beyond the scope of this article. METHOD The 4K camera is set to cover the whole water surface of a pool. Usually we set the camera in the middle of the longer side of the pool at higher elevation of audience seats. The 4K race video is marked with a starting signal of a race. The video is then geometrically undistorted in order to remove the artifact of lens distortion. Since the water surface can be recognized as a plane, homography projection can be applied so that we can obtain a pool region in rectangle shape. Four corners of the pool should be manually given before we start the process. Since the video process of undistortion and homography projection does not high computation cost, it could be processed within a couple of minutes for a race. Both the perspective video (original video) and the squared video are utilized to produce the final digital zoom video of each swimmer in each lane. The perspective video is good for providing natural zoom view of swimming while the squared video has the advantage of clearly showing the location along a swimming lane. In order to help reviewing process, virtual lines are imposed on water surface at every five meters in both perspective video and the squared video. IMPLEMENTATION AND DISCUSSION Our preliminary system has been implemented on a laptop computer with Intel-i7. OpenCV is used for video conversion part. When we align the longer side of 4K image with the longer side of the pool, the upper limit of the resolution is 1.3 cm/pixel. It is about 5 cm/pixel in practical camera set-up. The final video can contain a couple of zoom video in any layout. After we have interviewed swimming coaches, we have adopted two perspective zoom video in different zoom parameter and one squared video which covers whole lane in the aspect of 100:5 (50 meters by 2.5 meters). We adopt the resolution of 1920 pixels by 1080 pixels in MP4 format because it could be played in major popular devices. We have got comments from swimming coaches who tell more resolution is needed when they see the final video in large display. We are planning to utilize multiple 4K cameras to archive higher resolution. CONTACT [kameda@iit.tsukuba.ac.jp](mailto:kameda@iit.tsukuba.ac.jp)

### PERFORMANCE TIME DIFFERENTIALS OF ELITE ALPINE SKIERS

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PERFORMANCE TIME DIFFERENTIALS OF ELITE ALPINE SKIERS Introduction The difference between winning an alpine ski World Cup race and missing the podium may be a fraction of a second. To date, there is limited information documenting the performance time differentials of elite skiers. The aim of this study was to provide a detailed analysis of the time differentials in the downhill (DH) and super-G (SG) disciplines. Methods Official race times and course information for men's and women's DH and SG World Cup competitions from seasons 2001-2013 were downloaded from [fis-ski.com](http://fis-ski.com). In analyses of the top 30 athletes from each race there were 66 to 103 races in total. Performance time differentials for each fifth place (i.e., 1 to 5, 6 to 10... 26 to 30) were documented for each race. Comparisons between DH and SG, sexes and periods (seasons 2001-2006 vs 2007-2013) were analyzed. The percentage likelihood of difference between comparisons was calculated and considered meaningful for likely (>75%), very likely (>99%), or almost certainly (>99.5%) (Hopkins et al., 2009). Results There were likely to most certainly time differentials between place 1 to 5 for DH and SG for both sexes (mean  $\pm$  SD; men: 0.63  $\pm$  0.28, 0.52  $\pm$  0.23 s; women: 0.64  $\pm$  0.28, 0.57  $\pm$  0.25 s; respectively) versus all other place categories (range; men: 0.33-0.39, 0.32-0.35 s; women: 0.32-0.38, 0.31-0.35 s). When comparing the early seasons to the later seasons, mostly trivial differences were

evident for both disciplines and sexes. Discussion The greater time differentials for place 1 to 5, when compared to the other place categories, highlights the dominance of these very elite skiers. This may be due to a combination of individual variation, superior fitness, technique, psychology or coaching and technical support. Comparable findings were reported in sprint prologue races of elite cross-country skiers (Spencer et al., 2013), suggesting that this effect may not be sport specific. The lack of meaningful differences between season periods suggests that the competition depth has remained stable over the seasons investigated. References Hopkins, W.G., Marshall, S.W., Batterham, A.M., Hanin, J (2009). *Med Sci Sports Exerc.*, 41(1):3–12. Spencer, M., Hallén, J (2013). 6th International Congress on Science and Skiing (ICSS), St. Christoph a. Arlberg, Austria. Contact: matt.spencer@nih.no

### PHYSIOLOGICAL RESPONSES AND PHYSICAL ACTIVITY IN SMALL-SIDED GAMES FOR COLLEGIATE SOCCER PLAYERS

Takai, Y., Horio, K., Kai, T., Aoki, T.

*National Institute of Fitness and Sports in Kanoya*

Purpose: Small-sided games (SSGs) are often used as part of training in soccer, regardless of playing level and age. There are many earlier findings concerning SSGs in professional and semi-professional soccer player (e.g. Owen et al., 2012; Casamichana et al., 2014), but less information is about SSGs in collegiate soccer players. The purpose of this study was to clarify the difference in physiological responses and physical activity of SSGs in collegiate soccer players. Methods: Twelve collegiate male soccer players conducted SSGs (3 sets × 4 min with interval of 4 min passive recovery, 40 × 30m) in 5 conditions; 3-a-side SSG (150 m<sup>2</sup>, pitch area per player), 4-a-side SSG (120 m<sup>2</sup>), 5-a-side SSG (100 m<sup>2</sup>), and 4-a-side with a free player (109 m<sup>2</sup>), SSG with less than 2 ball touches (120 m<sup>2</sup>). The players were randomly assigned in two teams, and measured during each SSG. All games were played on an outdoor grass field and included in two goalkeepers. The activity of player was determined by using global positioning system (15 Hz) in the SSGs. The total distance covered and the distance covered of the following velocity zone (<1.7, 1.7-3.3, 3.3-5.0, and >5.0 m/s) were calculated from the obtained two-dimensional position coordinate data. The high-intensity running distance covered was defined as the distance covered over 5.0 m/s. Heart rate was continuously monitored during the SSGs. Maximal heart rate (HRmax) was determined using the Yo-Yo Intermittent Recovery Test Level 1. The mean heart rate during the SSG was divided into HRmax (% HRmax). Results: The total distance covered in the 3-a-side SSG (1771 m) was higher than the other SSGs (1589-1648 m). High-intensity running distance covered (148 m), mean heart rate (169 bpm) and % HRmax (88% HRmax) in the 3-a-side SSG were higher than the other SSGs (67-148 m, 154-161 bpm, 80-84% HRmax), except for the 4-a-side SSG (100 m, 163 bpm, 84% HRmax). There were no effects of ball touch restriction and a free player in the distance covered, mean heart rate and % HRmax. Mean heart rate and % HRmax during warm up did not significantly differ among the conditions. The score of Yo-Yo IR1 was positively related to the total distance covered in the 3-a-side SSG ( $r = 0.58$ ), and the distance covered over 5.0 m/s in the 4-a-side with a free player ( $r = 0.62$ ). Conclusion: The current results that, within same pitch size, physiological response and physical activity of SSG depends on pitch area per players in collegiate soccer players, regardless of ball touch restriction and a free player. Owen AL1, Wong del P, Paul D, Dellal A. (2012). *J Strength Cond Res*, 26(10), 2748-54. Casamichana D, Suarez-Arrones L, Castellano J, Román-Quintana JS. (2014). *J Hum Kinet.* 8, 41, 113-23.

### EFFECT OF PLAYING LEVEL ON MATCH-PLAY ACTIVITY PROFILE IN COLLEGIATE SOCCER

Horio, K., Takai, Y., Aoki, T., Kai, T., Yamamoto, M.

*National Institute of Fitness & Sports in Kanoya*

Purpose: Elite soccer players have a greater the amount of high-intensity running in a competitive match than mature players (Mohr et al., 2003). Furthermore, the amount of high-intensity running differ among positions (Di Salvo et al., 2006). However, whether the earlier findings can be applied to collegiate soccer players within same team is still remained. The purpose of this study was to examine the effects of playing level and position on match-play activity profile in collegiate soccer players within same team. Methods: Collegiate soccer players participated in this study, and were divided into regular group and non-regular group, excluded in goalkeeper. All games were played on an outdoor grass field. The match-play activity was determined by using global positioning system (15 Hz) in their official and practice matches (90 min/match). The total distance covered and the distance covered of the following velocity zone (<1.7, 1.7-3.3, 3.3-5.0, 5.0-6.7, 6.7-8.3, and >8.3 m/s) were calculated from the obtained two-dimensional position coordinate data, respectively. The distance covered (m) was divided into pitch size (m<sup>2</sup>) because the pitch size differed among matches. The distance covered over 5.0 m/s was divided into the total distance covered. Results: The total distance covered per pitch size was higher in non-regular group than in regular group, except for side midfielder. The distance covered over 5.0 m/s in the regular group was higher than that in the non-regular group for central midfielder and side defender. The significant differences in total distance covered, distances covered over 5.0 m/s and over 6.7 m/s were found among positions in the regular group. There were less significant differences in the corresponding variables in the non-regular group. The percentage of distance covered over 5.0 m/s to total distance covered in the regular group ( $10.4 \pm 1.5\%$  for central midfielder, and  $13.0 \pm 1.7\%$  for side defender) was higher than that in non-regular group ( $6.4 \pm 1.5\%$ , and  $9.0 \pm 2.9\%$ ). Conclusion: The current findings indicate that, even within same team, regular players of central midfielder and side defender can perform more high-intensity running than non-regular players of the corresponding positions in a match. Mohr M, Krusturup P, Bangsbo J. Match performance of high-standard soccer players with special reference to development of fatigue. *J Sports Sci.*, 21(7):519-28, 2003. Di Salvo V, Baron R, Tschan H, Calderon Montero FJ, Bachl N, Pigozzi F. Performance characteristics according to playing position in elite soccer. *Int J Sports Med.*, 28(3):222-7, 2007.

16:20 - 17:50

## Invited symposia

**IS-PM09 PERFORMANCE AND TRAINING OF THE TOP-ATHLETE \*****THE EFFECT OF INTENSIFIED TRAINING; TRAINING OF THE TOP-CLASS OARSMAN**

Christensen, P.

*University of Copenhagen, Team Danmark*

Olympic level rowing is performed over a 2000-m distance lasting ~5.5 - 7 min depending on water and weather conditions. Such an effort relies mainly on aerobic metabolism, but the capacity for potassium (K<sup>+</sup>) and hydrogen (H<sup>+</sup>) ion transport and anaerobic power for starts and sprints are also considered as important. High intensity training in rowing can be defined as intensities between race pace and maximal intensity. Race pace training is performed with a mean power of ~450 and ~500 W for international level Danish male light-weight (LW, < 72.5 kg) and open-weight (OW) rowers, respectively, which can be sustained for ~3-6 min eliciting values close to VO<sub>2</sub>-max. In maximal sprints average power for a 15-s effort is ~800 W for LW and ~1000 W for OW. In trained subjects, race-pace intensity training (3-6 min intervals) appears to improve mainly VO<sub>2</sub>-max, in particular with block periodization (1). Oxidative enzymes are often unchanged, however specific adaptations have been found in high order motor units (2) which are likely taxed in maximal rowing. Moreover, oxidative enzymatic adaptations may be augmented when performing such training on low glycogen levels (3) but the functional significance of this with regards to performance at high intensity is unknown. Little is known with regards to effects on ion transporters and angiogenesis. Repeated sprint training (eg. 30-s intervals) appears to have minor effect on VO<sub>2</sub>-max, angiogenesis and oxidative enzymes, whereas an increase in the content of H<sup>+</sup> and K<sup>+</sup> transporters has been observed (4,5). Taken together, race-pace and repeated sprint training appear to act through distinct mechanisms and are considered important for performance. Yet, a small part (<5%) of the total training volume from January to end of August (world championships) is performed at these intensities in Danish elite rowers. However, the demand for recovery and mental and technical aspects are important factors that the experienced coach needs to balance in the training plan. In turn, low intensity training (6) and accumulated training volume (7) appear to elicit the strongest angiogenic stimuli which may be important for exchange of metabolites and oxygen during intense exercise (8). Training slightly below race-pace intensity also stimulates the cardio-vascular system and muscular adaptations with Danish elite rowers undertaking significant parts (>10%) of training at such intensity during the season. 1. Rønnestad et al. 2014, Scand J Med Sci Sports Feb 24(1) 2. Kohn et al. 2011, Scand J Med Sci Sports Dec 21(6) 3. Yeo et al. 2008 J Appl Phys Nov 105(5) 4. Iaia et al. 2008, Am J Phys Reg Int Comp Mar 294(3) 5. Bangsbo et al. 2009, J Appl Phys Dec 107(6) 6. Nybo et al. 2010, Med Sci Sports Exerc Oct 42(10) 7. Rodriguez et al. 2002, Am J Phys Med Rehabil Sep 81(9) 8. Iaia et al. 2011, J Appl Physiol Jun 110(6)

## Invited symposia

**IS-PM13 SKELETAL MUSCLE LIPOTOXICITY; SHOULD WE BE INTERESTED?****SKELETAL MUSCLE LIPOTOXICITY: WHAT IS IT AND WHAT DOES IT DO?**

Schrauwen, P.

*Maastricht University*

Skeletal muscle plays an important role in the regulation of glucose homeostasis as it is responsible for ~ 80% of postprandial glucose uptake. In obesity, excessive fatty acids not only accumulate in adipose tissue but also in liver, heart and the muscle. In skeletal muscle, fat accumulation inside the muscle cell is associated with the development of insulin resistance and mitochondrial dysfunction, often referred to as lipotoxicity. Remarkably, however, endurance trained athletes are also characterized by elevated levels of intramyocellular lipids despite being very insulin sensitive. This so-called 'athletes paradox' has been explained by differences in the content of fatty acid intermediates that could interfere with insulin signaling between obese subjects and endurance trained athletes, but recent data questions this explanation. Recently, evidence is starting to accumulate that lipid droplet dynamics may play an important role in determining the lipotoxic effects of intramyocellular lipids. Thus, in muscle fatty acids are stored in lipid droplets that are surrounded by a large number of so-called lipid droplet coating proteins called perilipins. Overexpressing perilipin-2 or -5, the most abundant muscle PLINs - prevent the development of lipid-induced insulin resistance. Interestingly, PLIN content is increased in endurance trained athletes and under the transcriptional control of PGC1 $\alpha$ , a transcription co-activator involved in mitochondrial biogenesis. These data point towards a concerted regulation of mitochondrial and lipid droplet biogenesis, which may be disturbed in type 2 diabetes.

**'THE EFFECTS OF EXERCISE TRAINING ON SKELETAL MUSCLE LIPIDS'**

Goodpaster, B.

*Translational Research Institute for Metabolism and Diabetes*

Session-ID: IS-PM13 'Skeletal muscle lipotoxicity: should we be interested?' Date: 25.06.2015 Intramyocellular lipid (IMCL) is predominantly stored as intramuscular triglyceride (IMTG) in lipid droplets. Excess IMTG storage and/or decreased utilization was initially implicated in muscle insulin resistance (IR) in obesity, aging and type 2 diabetes. Exercise training, however, can promote enhanced storage and utilization of IMTG. Thus it has become apparent that IMTG do not actually cause IR, but rather, an excess accumulation of other lipid moieties such as long chain acyl CoA's, ceramides, and diacylglycerol are the more likely culprits. The aim of this presentation is to review current knowledge of IMCL-mediated IR and to cover emerging and important areas of investigation, including myocellular lipid transport and lipid droplet protein metabolism. We also identify several crucial questions that remain unanswered. For example, it is not yet clear which specific DAG and ceramide species, and from which subcellular location, may mediate IR in human muscle. Also, the evolving

nature of “mitochondrial dysfunction” in IR is discussed. Targeted, quantitative lipidomics coupled with novel model systems and clinical investigations in humans will better define the underlying mechanisms for pathological IMCL accumulation and IR.

### EFFECTS OF SKELETAL MUSCLE LIPOTOXICITY ON MUSCLE PROTEIN SYNTHESIS: IMPLICATIONS FOR ATHLETIC AND AGEING POPULATIONS

Guillet, C.

*University of Auvergne*

Ectopic lipid accumulation in skeletal muscle is linked to reduced insulin sensitivity in various groups of subjects. The increased lipid content within muscle in older people is independently associated with insulin resistance. Physical exercise improves muscle lipid infiltration and insulin resistance in postmenopausal women. Beside the consequence of muscle fat accumulation on insulin sensitivity, some evidences clearly show that high fat feeding in young mice influences the ability of muscle to hypertrophy in response to anabolic stimuli (Anderson, 2008). In addition, muscle fat accumulation in older people is associated with poorer strength and poor physical performance and subsequent disability. A negative relationship has been highlighted between body fat mass and muscle protein synthesis in young and elderly people (Guillet, 2009; Katsanos, 2011). These observations suggest that an increase in adipose or ectopic fat mass may affect protein kinetics within skeletal muscle. Recent data have clearly shown that intra-muscular lipid deposition during aging affects protein synthesis via impairment in the regulation of a specific factor of intracellular signaling pathway of insulin: eIF2- $\alpha$  (Tardif, 2014). This effect has also been demonstrated in adult rats in which lipid accumulation in muscles during prolonged obesity is deleterious for amino acid incorporation in skeletal muscle proteins (Masgrau, 2012). In vitro and in vivo data have shown that the deleterious effect of intra-muscular fat accumulation on muscle protein synthesis might be due to a specific reactive lipid species. Indeed the accumulation of ceramides within muscle is linked with the reduction of muscle protein synthesis and the hyperphosphorylation of eIF2- $\alpha$  (Tardif, 2014). The effect of muscle lipotoxicity on muscle protein synthesis could also be due to an indirect effect through the modulation of insulin sensitivity and inflammation by the nature of lipids ingested. For instance, in old rats fed a high-fat oleate-enriched diet, insulin sensitivity and inflammation are improved and concomitantly skeletal muscle protein synthesis is enhanced (Tardif, 2011). Recent data provide strong arguments for the involvement of muscle lipotoxicity in reduction of muscle protein synthesis during ageing. This process may contribute to the loss of muscle mass and function observed in elderly people, defined as “sarcopenia”. References: Anderson SR, et al. (2008). *Metabolism*, 57, 347–354. Guillet C, et al. (2009). *J. Clin. Endocrinol. Metab.*, 94, 3044–3050. Katsanos CS, et al. (2011). *Obesity*, 19, 469–475. Masgrau A, et al. (2012). *J. Physiol.*, 590, 5199–5210. Tardif N, et al. (2011). *Clin. Nutr.*, 30, 799–806. Tardif N, et al. (2014). *Aging Cell*, 13, 1001–1011. [Christelle.Guillet@udamail.fr](mailto:Christelle.Guillet@udamail.fr)

## Oral presentations

### OP-BN16 Coaching: Mixed session II

#### WHO ARE THE PARENTS? A STUDY OF THE PARENTAL BACKGROUND OF CHILDREN AGE 13-14 INCLUDED IN THE FIRST TALENT PROCESS STEPS IN SOCCER AND ATHLETICS IN SOUTHERN SWEDEN.

Hafsteinsson Östenberg, A., Linnér, S., Strömberg, C., Fahlström, P.G.

*Sport Science*

Who are the parents? A study of the parental background of children age 13-14 included in the first talent process steps in soccer and athletics in southern Sweden. Introduction Literature including talent development is usually concentrated on physical performance in sports (Ericsson et al., 1993, Brown et al., 2001). Also different cultural aspects, i.e. the importance of the coach and parents have been studied (Coté, 1999; Kay, 2003). However, research of the importance of the parents is limited. This study has its theoretical view of origin in Bourdieu (1978) who relates to habitus and social capital and the purpose was to study family background and family support among the athletes/players who were included in the first talent process in athletics and soccer in southern Sweden. Methods Participants were parents to children (age 13-14) participating in athletics (qualified) and soccer (chosen by the federation). Data was collected using inquire that was sent out by mail to all parents of the participating children and data was processed using SPSS. Results A total of 419 (48%) families (292 soccer/127 athletics) answered the questionnaire. Of the parents, 95% were real estate owners and worked full time, 38% and 68% of the parents of soccer player and athletics respectively had a university degree and 90% had very good grades in physical education in high school. 87% of the parents had participated in sports during their childhood. It was important to men, especially soccer parents, that their child was successful in sports. 95% were very interested in and 96% were engaged in their child's sport. 77% of the men and 50% of the women considered themselves being knowledgeable in their child's sport and 50% thought it was important for the child. Approximately 75% gave their children advice during training and game/competition, 35% encouraged extra practice and 80% drove their children to practice and games/competitions. Discussion The results of this study are in accordance with earlier research and show the importance of the family in youth talent development processes. The results raise questions if family background, socioeconomic status and commitment of parents are to be seen as a direct prerequisite for children's sporting activities and performance development? The results also raise questions about who is included in a talent development process. References Bourdieu P. (1978) *Social Science Information*, 17(6) 819-840. Brown, Jim. (2001). *Human Kinetics*. Coté J. 1999. *The Sports Psychologist* 1(3) 395-414. Ericsson KA. (1993). *Psychological Review* (3) 363-406. Kay T. (2000). *European Physical Education Review* 6 (2) 151-169. Lund S, Olofsson E. (2009) *SVEBIs Årsbok* 125-150. Storm LK, Henriksen C, Krogh-Christensen M. (2012). *Int. Journal of Sport Psychology*, (43) 199-222.

#### PREDICTION OF PERFORMANCE IN MONOFIN SWIMMING WITH THE DYNAMOMETER. A PILOT STUDY

Rozi, G.

*NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS*

Introduction Strength measuring is a necessary source of information in training procedure (Marinho & Orival, 2002). The ability of muscles to contract and so produce the greatest force in the shortest possible time is called explosiveness (Dopsaj, 2004). The aim of this study is to define a mathematical model for sprint fin swimmers (50 and 100 m swimming with monofin) to be used in predicting performance results, based on the indicators that assess explosiveness, which is diagnosed for different muscle groups. Methods In the re-

search 8 fin swimming athletes participated, aged  $17 \pm 0.4$  years, height  $176 \pm 5$  cm and weight  $72 \pm 5$  kg. The participants swam in two different days 50m and 100m with a snorkel and monofin on the surface of the water with maximum intensity. In next two days maximum pulling force of legs and of ankle extensors were measured in the gym with a tensiometric dynamometer. For the analysis of the results, multiple regression analysis was applied with the statistical program SPSS 22. Results The results showed that average maximum pulling force for legs was  $1302,62 \pm 696,05$  N, average maximum pulling force for ankles extensors was  $2689,14 \pm 617,13$  N. The analysis of the results showed that for 50m with monofin, none of the two variables are good predictors. On the other hand, the maximum force of legs is best predictor for the performance of 100m with monofin. The two variables explained the 43,9% of the variance of 100m performance time with monofin (Sig. .043). The pulling force of leg has a positive correlation with performance time in 100m and is the best predictor for the dependent variable- time in 100m. Discussion This research showed that there are specific parameters that can predict performance in monofin swimming. Using the model that occurs from the analysis, a trainer can create the actual competitive fitness level for each swimmer for 100m. Furthermore, such a procedure that controls the swimmer's fitness level on land enables more accurate management of the training process. Other physiological, biomechanical and parameters of strength, should be studied in order to create a better predictive model for monofin swimming. References 1.Dopsaj, M., Thanopoulos, V., Race, V., & Okicic, T. (2004). The relationship between competitive fitness levels in top sprinters swimmers at 50m and 100m freestyle and indicators of explosiveness of different muscle groups: a result prediction model. XIth International conference on strength training. 153-154. Serres. Greece. 2.Marinho, P. & Orival, A. (2002). Isometric force assessment and influence on the maximum velocity of swimmers of different levels. *Biomechanics and Medicine in Swimming IX*. Saint Etienne. 349-354

## SPECIALISING OR SAMPLING - CAREERS PATHWAYS IN SWEDISH ELITE SPORTS

Fahlstrom, P.G., Gerrevall, P., Glemne, M., Linnér, S.

*Linnaeus University*

Introduction The sport talent discourse is dominated by the controversy regarding early specialization or sporting diversification and sampling (Cote & Fraser-Thomas, 2007 and Bridge & Toms, 2012). The main purpose of the project was to study Swedish top athletes and describe the pathways to national top level in sports and the athletes' perception of this process. More specifically the project studied socio-economic background, families sporting background, sports debut age, age of specialisation and investing in sports. Method Questionnaires were distributed to 349 national team athletes from 39 different sport federations. 328 athletes, 195 females and 133 males, returned the questionnaires, an answering rate of 93,8%. The average age was 25 years. 62% were involved in individual sports. They were all nations team athletes and 69% of them had received special elite support as potential medal winners at World Cups and Olympic games. Results The study showed the strong family influence on the sport activities. The national team athletes typically came from sport families, their parents had own sport experiences often from a high level within the same sport as the children. The parents often were engaged as coaches, committee delegates, board members etc. The study identified several different paths to the national team. The career steps from early involvement to top level performances are varying and individual. Beside the two dominating paths the results showed different nuances and individual pathways including early sport choice but with early or late specialization as well as later sport choice with or without sampling periods. These results are corresponding with other recent studies (see for example Storm et al 2012). Discussion The findings in this study indicate that the talent programs and talent identification systems have to be more flexible to match the different individual pathways to elite level. The standardized talent programs and the traditional talent "stairways" are discussed since they run the risk of missing talents who don't seem to fit expected sport activity patterns. References Bridge, M. W. & Toms, M.R. The specialising or sampling debate: a retrospective analysis of adolescent sports participation in the UK, *Journal of Sports Sciences*, 2012; 1-10 Côté, J. & Fraser-Thomas, J. Youth involvement in sport. In P. Crocker (Ed.), *Introduction to sport psychology: A Canadian perspective* (pp. 266-294). Toronto, ON: Pearson Prentice Hall. Storm, L. K., Henriksen, C. & Krogh-Christensen, M. Specialization pathways among elite Danish athletes: A look at the developmental model of sport participation from a cultural perspective. *International Journal of Sport Psychology*, 2012, 43, 199-222

## PREDICTING SPECIFIC PERFORMANCE VIA CRITICAL VELOCITY AND MODIFIED-WINGATE TEST IN KAYAK ATHLETES

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*Graduate Institute of Athletics and Coaching Science, National Taiwan Sport University*

Introduction The canoe/kayak athletes' performance appears to be affected by both aerobic capacity and anaerobic power. However the equipment of VO<sub>2</sub>max test is expensive and the measurement is time consuming. The critical velocity (CV) model and Wingate test offer a convenient method to examine exercise capacity in athletes. The aims of this study are to develop a model to estimate kayak athletes' aerobic and anaerobic capacities and to predict the performance of flat water sprint kayaking by CV and a modified-Wingate test on kayak ergometry. Methods Fifteen male junior kayak athletes (age  $15.6 \pm 2.9$  years old; height  $170.6 \pm 5.5$  cm; body mass  $65.3 \pm 8.5$  kg; body fat  $16.9 \pm 4.8$  %) were volunteered to participate in the study. Participants were asked to complete four experimental trials including a kayak ergometry CV tests modified according to Kendall et al. (2011) at 200-m, 500-m, 1000-m and 2000-m, a kayak ergometry modified-Wingate 30s sprint test, and a 200-m and a 1000-m open water kayaking sprint tests. Performance times, heart rate and blood lactate responses were recorded in every trial. Results The average results of ergometry CV test and modified-Wingate test were  $3.14 \pm 0.21$  m/s in CV and  $351.9 \pm 93.5$  W,  $15.9 \pm 4.9$  kW,  $281.8 \pm 62.5$  W,  $226.9 \pm 53.0$  W and  $254.5 \pm 58.2$  W in Ppeak, AnC, Pmax, Pmin and Pmean respectively. The 1000-m open water kayaking time ( $284.2 \pm 26.7$  s) was significantly correlated to the CV ( $r = -.900$ ), the ergometry 1000-m paddling test ( $r = .898$ ), and the modified-Wingate test ( $r = .805$ ). The best regression formula of predicting the 1000-m open water kayaking time was  $Y = 642.06 - 113.9 \times CV$  ( $R^2 = .810$ ,  $p = .000$ ). The 200-m open water kayaking time ( $40.6 \pm 4.7$  s) was significantly correlated to the CV ( $r = .814$ ), the ergometry 200-m paddling test ( $r = .592$ ), and the modified-Wingate test ( $r = .930$ ). The best regression formula of predicting the 200-m open water kayaking was  $Y = 69.957 - 0.093 \times Pmin + 0.058 \times Pmean - 0.001 \times AnC + 0.012 \times Pmax$  ( $R^2 = .865$ ,  $p = .000$ ). Discussion The main findings of this study suggest that the CV is a better indicator of predicting a 1000-m open water kayaking performance than modified-Wingate test because the CV was highly related to VO<sub>2</sub>max and lactate threshold positively (Clarke et al., 2014; Clark et al., 2013; Kendall et al., 2011). Whereas, the modified-Wingate test is a better indicator to predict a 200-m open water kayaking performance than the CV since the shorter distance kayaking depends on more anaerobic metabolism. References Clark I, West B, Reynolds S, Murray S, Pettitt R. (2013). *J Strength Cond Res*, 27(12), 3335-3341. Clarke A, Presland J, Rattray B, Pyne D. (2014). *J Sci Med Sport*, 17, 144-148. Kendall K, Smith A, Fukuda D, Dwyer T, Stout J. (2011). *J Sports Sci.*, 29(9), 945-950. Contact E-mail address: lee@ntsuo.edu.tw (Dr Tzai-Li)

## Oral presentations

### OP-PM13 Physiology: Endurance

#### ALMOST PERFECT CORRELATION BETWEEN HEMOGLOBIN MASS, MAXIMAL O<sub>2</sub>-UPTAKE AND LEAN BODY MASS IN 13 YEARS OLD BOYS AND GIRLS

Landgraff, H., Hallén, J.

*Norwegian School of Sport Sciences*

**INTRODUCTION:** It has been suggested that lean body mass (LBM) is a more appropriate anthropometrical reference for the hemoglobin mass (Hb-mass) than body weight (Schumacher, Ahlgrim & Pottgiesser, 2008). This conclusion was based on measurements on a homogenous endurance trained male athletic population. Whether these findings can be transferred to other groups such as females or children is unknown. Our study aimed to investigate if there is an association between LBM and changes in Hb-mass in a group of 13 years old Norwegian cross country skiers of both sexes. **METHODS:** Sixty-six Norwegian children (boys n=44, age 13.4 ± 0.2 and girls n=22, age 13.4 ± 0.2) were recruited from cross-country ski clubs. Hb-mass was determined using the optimized CO rebreathing method. VO<sub>2</sub>max was measured directly while running to exhaustion on a motor driven treadmill. Body composition was determined by InBody 720 bioelectrical impedance analysis. Correlations between variables were assessed by Pearson's product-moment correlation and correlation coefficients were classified as small (0.1≤r<0.3), moderate (0.3≤r<0.5), high (0.5≤r<0.7), very high (0.7≤r<0.9) and almost perfect (r≥0.9) (Hopkins, 2000). **RESULTS:** VO<sub>2</sub>max and Hb-mass were almost perfectly correlated in boys (r=0.90; p<0.01) and very highly correlated in girls (r=0.82, p<0.01). The correlations between Hb-mass and body weight were very high in both boys (r=0.87, p<0.01) and girls (r=0.77, p<0.01). Similarly, the correlations between Hb-mass and LBM were almost perfect in boys (r=0.91, p<0.01) and very high in girls (r=0.86, p<0.01). The correlations between VO<sub>2</sub>max and body weight were very high in boys (r=0.85, p<0.01) and high in girls (r=0.67, p<0.01) and the correlations between VO<sub>2</sub>max and LBM were almost perfect in boys (r=0.90, p<0.01) and very high in girls (r=0.80, p<0.01). **DISCUSSION:** It has previously been shown that VO<sub>2</sub>max and Hb-mass relative to body weight are highly associated (Eastwood et al., 2009). This is also the case in the present study (data not shown). However, the present study shows that both VO<sub>2</sub>max and Hb-mass are almost perfectly associated to LBM. This indicates that relative VO<sub>2</sub>max and Hb-mass are negatively associated with the body fat percentage. **REFERENCES:** Schumacher YO, Ahlgrim C, Pottgiesser T. *J Sports Med Phys Fitness*. 2008 Dec;48(4):509-14. Hopkins, W. G. A scale of magnitudes for effect statistics. In: *A New View of Statistics*. Internet Society for Sport Science 2000: <http://www.sportsci.org/resource/stats/>. Eastwood A, Bourdon PC, Withers RT, Gore CJ. *Eur J Appl Physiol*. 2009 Mar;105(5):715-21. Contact: Hege Wilson Landgraff. E-mail: h.w.landgraff@nih.no

#### THE CORRELATION BETWEEN ONE YEAR CHANGE IN MAXIMAL OXYGEN CONSUMPTION, HEMOGLOBIN MASS, MUSCLE MASS AND BODY WEIGHT IN 12-13 YEARS CHILDREN

Riiser, A.1, Hege Wilson Landgraff, H.W.2, Hallén, J.2

*1 Sogn og Fjordane University College, 2 Norwegian School of Sport Sciences*

**Introduction** Maximal oxygen consumption (VO<sub>2</sub>-max) has been shown to be associated with hemoglobin mass (Hb-mass) in children as well as adults. The present study aims at investigating correlations between change scores over one year of VO<sub>2</sub>-max and Hb-mass in 12-13 years old schoolchildren. Secondly we aimed to examine if the change scores in VO<sub>2</sub>-max and Hb-mass are associated with increases in muscle mass or body weight. **Methods** In schoolchildren VO<sub>2</sub>-max was measured directly while running to exhaustion on a motor driven treadmill. Hb-mass was measured by the optimized CO-rebreathing method and muscle mass and body weight was assessed by InBody 720. The same children were tested twice one year apart at age 12.5 (SD 0.2) and 13.5 (0.2). Valid data both years were obtained from 25-30 children. Correlations between change scores of the different variables were assessed by Pearson's product-moment correlation and correlation coefficients were classified as small (0.1≤r<0.3), moderate (0.3≤r<0.5), high (0.5≤r<0.7), very high (0.7≤r<0.9) and almost perfect (r≥0.9) (Hopkins, 2000). **Results** Change in VO<sub>2</sub>-max was very highly associated with change in Hb-mass (r=0.71; p<0.001). Change in VO<sub>2</sub>-max was also very highly associated with change in muscle mass (r=0.74; p<0.001), but only moderately associated with body weight (r=0.39; p=0.031). Likewise, change in Hb-mass was very highly associated with change in muscle mass (r=0.76; p=0.001), but only moderately associated with change in body weight (r=0.40; p<0.024). **Discussion** It has previously been shown a high correlation between VO<sub>2</sub>-max and Hb-mass, both in adults and children. This study adds to this by showing that also change scores of these variables over one year are very highly correlated in children. Furthermore, the data indicate that changes in both variables are more connected to change in muscle mass than change in body weight. **References** Hopkins, W. G. A scale of magnitudes for effect statistics. In: *A New View of Statistics*. Internet Society for Sport Science 2000: <http://www.sportsci.org/resource/stats/>.

#### MUSCLE RESPONSE TO COMBINED SPEED ENDURANCE AND ENDURANCE EXERCISE

Skovgaard, C., Pilegaard, H., Bangsbo, J.

*University of Copenhagen*

**Introduction** The aim of the present study was to investigate the mRNA response of human skeletal muscle to speed endurance exercise, endurance exercise and the combination of the two types of exercise. **Methods** Seventeen moderately trained subjects with an average age, height, weight and maximum oxygen uptake (VO<sub>2</sub>-max) of 23.6±1.0 (mean±SE) years, 183.4±1.4 cm, 75.5±1.5 kg and 57.2±0.9 ml O<sub>2</sub>/min/kg, respectively, took part in the study. Subjects completed three protocols (S; S+E; E) in a randomized crossover design with a minimum of 7 days between trials. S consisted of 6\*30-s all-out cycle sprint intervals (resistance: 56.6±1.2 N) separated by 3 min of rest with total work being 148±4 kJ. E consisted of 60 min of cycling with a power output of 156±5 W (60% VO<sub>2</sub>-max) corresponding to a total work of 188±6 kJ. S+E was performed as S followed by E after a 3-min break with total work being 334±8 kJ. A biopsy was taken from m. vastus lateralis at rest, before exercise (all trials), at the end of exercise (S+E and E) as well as 1h, 2h (all trials) and 3h (S only) after each exercise bout. **Results** In S, muscle PGC-1α mRNA was 7- and 5-fold higher (p<0.05) 2 and 3h after exercise (ae), respectively, 4- and 8-fold higher (p<0.05) 1 and 2 h ae in S+E, respectively, and 4-fold higher (p<0.05) 2h ae in E compared to rest, with the level after S+E being higher (p<0.05) compared to E (1 and 2h ae) and S (3h ae). In S, muscle hexokinase II mRNA was ~2 fold higher (p<0.05) 2 and 3h after compared to before exercise. Only in S+E, muscle HO-1 mRNA was higher (p<0.05) 0, 1 and 2h ae compared to rest. Elevated (p<0.05) muscle MRF-4 mRNA was found at the end of exercise in S+E and 2h ae in S+E and E. Lowered (p<0.05) level of myostatin was

observed in S+E 1 and 2 h ae. Discussion Combined speed endurance and endurance exercise lead to larger increases in PGC-1 $\alpha$  mRNA compared to speed endurance and endurance exercise performed separately, suggesting that speed endurance exercise reinforce the mitochondrial biogenesis effect of endurance exercise. Only combined speed endurance and endurance exercise elicited higher levels of HO-1 mRNA, which may be due to the higher oxidative stress associated with the larger total work performed compared to the protocols carried out separately. Lower levels of myostatin mRNA was found only with combined speed endurance and endurance exercise whereas higher levels of MRF-4 mRNA was found with combined speed endurance and endurance exercise and only endurance exercise, suggesting a significant effect of endurance exercise on myogenic regulators. Only speed endurance exercise elicited changes in hexokinase II mRNA but not when endurance exercise was added, suggesting that endurance exercise blunted the effect of speed endurance exercise. Contact c.skovgaard@nexs.ku.dk

### COGNITIVE ACTIVITY AND CEREBRAL OXYGENATION DURING A 20-KM CYCLING TIME TRIAL

McCarron, J., Smith, M.F.

*University of West England at Hartpury College*

Introduction Maintenance of cerebral oxygenation (O<sub>2</sub>Hb) within a stable range during endurance exercise is thought to contribute to successful performance (Nielsen & Seifert, 2011). This may be due to the importance of cognitive processes inherent within the ability to regulate pace (Renfree et al., 2013). Yet cognitive function has been suggested to be impaired during high intensity exercise (Dietrich & Audiffren, 2011). Using a dual-task paradigm this study explored the phenomenon of pacing through evaluating the impact of increased cognitive load at different stages of a cycling time trial (TT) on cerebral O<sub>2</sub>Hb, pacing and time to completion. Methods Twelve well-trained cyclists (31  $\pm$  9 yrs, PPO 352  $\pm$  29 W, VO<sub>2</sub>peak 57  $\pm$  6 ml·kg<sup>-1</sup>·min<sup>-1</sup>) performed, in a randomised order, 4 simulated 20-km cycling TTs on separate occasions. These included a control simulated 20-km TT (TTCO) and 3 experimental conditions in which participants concurrently performed an executive cognitive task for the duration of the 1st half (TT1stHCL), the 2nd half (TT2ndHCL) and the whole duration of the TT (TTFullCL). Cerebral O<sub>2</sub>Hb was assessed at the dorsolateral prefrontal cortex (dLPFC). Blood lactate (BLa), effort (TEA), exertion (P-RPE) and affect (FS) were measured. Results Completion time during TTCO (2122s  $\pm$  378) compared to all experimental conditions was significantly faster; TT1stHCL (2257s  $\pm$  382; p<0.01, partial  $\eta^2$ =0.93); TT2ndHCL (2205s  $\pm$  407; p<0.01, partial  $\eta^2$  =0.64); TTFullCL (2307s  $\pm$  411; p<0.01, partial  $\eta^2$ =0.79). Mean cerebral O<sub>2</sub>Hb increased in all conditions but did not change between conditions. Pacing profile was not different between TTCO and TTFullCL. Mean values of BLa, TEA, P-RPE and FS were not different between conditions, even though mean PPO was lower in experimental conditions. Cognitive performance was impaired in all conditions. Discussion Increased cognitive load has a detrimental impact upon endurance cycling performance. Upon an initial increase there was a plateau, then decline, in cerebral O<sub>2</sub>Hb during the cycling TT which was not affected by experimental conditions. This suggests a ceiling in O<sub>2</sub>Hb delivery to the dLPFC during endurance exercise performance. Thus, increased cognitive load led to a greater competition of dLPFC O<sub>2</sub>Hb delivery. For a given level of power output, TEA, P-RPE and FS increased in the experimental conditions. Therefore increased cognitive load carries an effortful cost that during self-paced endurance exercise may curtail the selected level of exercise intensity. During competition athletes should aim to reduce the cognitive load associated with pacing strategies. References Nielsen HB, Seifert T. (2011). *J Appl Physiol*, 110 (1):292. Renfree A, Martin L, Micklewright D, et al. (2014). *Sports Med*, 44(2): 147-58. Dietrich, A., Audiffren, M. (2011). *Neurosci Biobehav Rev*, 35, 1305-1325. Contact James.McCarron@hartpury.ac.uk

### COMPARISON BETWEEN PERPOT SIMULATED AND LACTATE BASED ANAEROBIC THRESHOLD IN HANDBALL PLAYERS

Endler, S., Hoffmann, S., Pfeiffer, M.

*Johannes Gutenberg University*

Introduction A main challenge for sport scientists and coaches is an individual intensity specification as exercise prescription for athletes (Hofmann and Tschakert, 2011). Ideally, in endurance sports percentages of the heart rate at maximal lactate steady state (MLSS) are used. Since the late 1970s, MLSS is approximated by several anaerobic thresholds based on lactate extraction during graded incremental tests. These invasive methods are expensive and laborious. Thus, scientists are looking for non-invasive methods to approximate these thresholds. Our new approach uses the sports computer science Performance Potential model (PerPot) for the determination (Perl, 2004). PerPot models a delayed heart rate progress related to a speed progress. The individual delays are determined using heart rate and speed progress during a graded incremental test. Our survey compares PerPot simulated and lactate based thresholds in handball players. Methods 15 male handball players performed a sports medicine diagnostic. Therefore, a graded incremental test (step duration 3 Min., initial workload 6 km/h and step incremental 2 km/h) with lactate extraction and continuous heart rate recording was performed on a treadmill. Lactate measurement was used for determination of four established lactate based anaerobic thresholds. Speed and heart rate processes were used for PerPot determination of the threshold. Results Both, Pearson correlations (.883 - .895) and intra-class correlation (.894 - .932) show high correlations between lactate based and PerPot simulated thresholds. Discussion Using anaerobic threshold for exercise prescription is the ideal case. However, anaerobic threshold changes because of training induced adaptations. Therefore determination should be repeated periodically. In practical, difficult invasive determination in laboratory and high cost leads to no repetition. Other non-invasive methods like Conconi could not achieve the desired precision (Carey et al., 2008). Our new non-invasive approach PerPot shows high correlations compared to lactate based thresholds. Besides low costs, another advantage is the easy portability of results to field, because graded incremental tests are not linked to laboratory anymore. It is therefore an ideal addition to sports medicine diagnostics. References Hofmann P., Tschakert G. (2011). Special needs to prescribe exercise intensity for scientific studies. *Cardiology research and practice*, 2011 Perl J. (2004). PerPot - a meta-model and software tool for analysis and optimisation of load-performance-interaction. *International Journal of Performance Analysis of Sport*, 4, 61-73 Carey DG, Pliego GJ, Raymond RL (2008). A comparison of different heart rate deflection methods to predict the anaerobic threshold. *European Journal of Sport Science*, 8, 315-323 Contact endler@uni-mainz.de

### LABORATORY PERFORMANCE PREDICTORS FOR MULTI-STAGE MOUNTAIN BIKE EVENTS

Engelbrecht, L., Greeff, M., Terblanche, E.

*Stellenbosch University, South Africa*

Introduction Mountain biking is one of the most rapid growing sports in the world with the number of multi-stage events increasing each year. A recurring question for exercise physiologists, coaches and athletes is whether laboratory measurements can predict field performance, as is the case for road cycling (Bentley et al., 2001). Performance predictors and exercise intensity profiling are thus valuable tools

for cyclists and coaches to optimize program design and event preparation (Lamberts, 2014). Methods 25 well-trained cyclists (22-56 years of age) performed a maximal aerobic capacity incremented exercise test eight weeks prior to participating in an 8-day multi-stage mountain bike event. Blood lactate measurements were taken during the incremental test to determine the lactate threshold (LT) and the 4 mmol/L lactate threshold (OBLA). Overall race time and final race classification were selected as dependent variables and the best subsets regression analysis was used to identify specific predictors from the physiological and performance variables obtained during the laboratory assessment. The best subset models were identified as those with the highest R<sup>2</sup> values and significance level less than 0.05. Results Absolute PO at OBLA ( $p = 0.01$ ) and relative PO at OBLA ( $p = 0.02$ ) were significant predictors for final event time and accounted for ~71% of the total race time. Statistically significant predictors for the cyclists' general classification were relative PPO ( $p = 0.02$ ) and relative maximal aerobic capacity ( $p = 0.048$ ), explaining 56% of the variance in general classification. Discussion The main finding of this study was that the laboratory variables were better at predicting total race time than general classification during a multi-stage MTB race. Similarly to road cycling, absolute and relative PO is important components of MTB performance and can be used as performance predictors for multi-stage MTB events. This is also in accordance with Impellizzeri et al. (2005), who reported strong correlations between absolute ( $r = -0.76$ ) and especially relative ( $r = -0.89$ ) PO at OBLA and total race time during a cross-country event. A maximal aerobic test combined with OBLA is therefore an effective laboratory assessment to measure in-field performance predictors. References Bentley D.J., McNaughton L.R., Thompson, D., Vleck V.E. & Batterham A.M. (2001). *Med Sci Sports and Exerc* 33, 2077-2081. Impellizzeri F.M., Rampinini E., Sassi A, Mognoni P. & Marcoca S. (2005) *Journal of Sports Sciences* 23(1), 41-47. Lamberts, R.R. (2014). *Int J Sports Physiol Perform* 9(4), 610-614. Do not insert authors here

## Invited symposia

### IS-BN05 PERFORMING WHEN GETTING OLDER: ALTERATIONS AND PLASTICITY OF THE AGEING NEUROMUSCULAR SYSTEM

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#### BRAIN FUNCTION AND MOTOR PERFORMANCE IN OLDER ADULTS

Swinnen, S.

*KU Leuven*

When older adults perform cognitive or motor tasks, they often show increased activation as compared to young adults. However, the mechanisms underlying these age-related changes in brain activation are still unclear. Changes in brain structure, in concentration of neurochemicals, and brain connectivity alterations may possibly contribute to this effect. Furthermore, it remains to be clarified whether this increased activation is associated with higher performance levels (compensatory mechanism) or whether it is a mere expression of neural irradiation (dedifferentiation) within the older adults' group. Reporting about several functional magnetic resonance imaging (fMRI) studies, we will address the following issues related to overactivation in older adults. First, we will document age-related activation increases during the production of motor coordination tasks and demonstrate that older adults exhibit increased cognitive control of action. Second, we will address evidence for compensatory recruitment by demonstrating that older adults who show higher activation levels as compared to those who do not, also exhibit higher motor performance levels (i.e., evidence for compensatory brain activation). Third, we will discuss whether these higher activation levels in older adults impose restrictions on modulation of brain activity as a function of increasing task difficulty. Finally, we will look into neuroplasticity during motor task learning in older adults and address the question whether training-induced plasticity allows the older adults to reduce these increased activation levels as compared to young adults.

#### AGE-RELATED NEUROMUSCULAR ADAPTATIONS

Baudry, S.

*Université Libre de Bruxelles*

Motor performance decreases with ageing, reflecting dysfunctions of the central and peripheral nervous systems, and the muscular system. The word sarcopenia has been used for a long time to describe the loss of muscle mass and associated motor functions in elderly adults. Nonetheless, the reorganisation of motor units (development of "giant" motor units), associated with other neural changes should also be considered when the functional alterations associated with senescence is evoked. Indeed, age-specific neural adaptations and modulation of corticospinal and spinal inputs converging onto motor neurone pool during various motor tasks have been documented. Nonetheless, although most of these changes would be considered as alterations, the ageing neuromuscular system also demonstrates increased functions such as greater relative fatigue resistance at submaximal force level. As a consequence, a better understanding of the age-related alterations in motor functions requires questioning the impact of neuromuscular changes occurring with ageing. The purpose of this symposium is to summarize the scientific knowledge related to age-related alterations in neuromuscular functions and their possible consequences on motor performance.

#### INFLUENCE OF MUSCLE STRENGTH ON PHYSICAL FUNCTION OF MEN AND WOMEN WITH AGE

Jakobi, J.

*University of British Columbia*

Exercise is the known most powerful intervention for the prevention of disease, the promotion of health, and for slowing age-associated physical and functional decline. Yet, present-day older adults are actually less physically active and are diagnosed with more chronic disease and disability than previous generations. Daily physical activity may not be enough to meet the health needs of society's current older adults, thus requiring planned exercise programmes to keep the ageing population healthy. This talk will summarize current evidence for plasticity in the neuromuscular system and the role of physical strength in sex-differences of functional aging. Long-term electromyography (EMG) recorded during daily life and laboratory-based functional tasks of steadiness will be discussed relative to differential changes in muscle strength, single fibre length and tendon stiffness between men and women with aging. Although exploration is in its infancy, it appears that women experience earlier onset of neuromuscular weakness and this contributes to earlier onset of declines in physical function. This symposium will be of interest to scientists, exercise leaders and health educators wanting to gain current



knowledge on the interrelationship between muscle strength and elasticity relative to sex-related differences in functional decline with age.

## Invited symposia

### IS-BN07 INTEGRATIVE APPROACH OF MUSCLE FATIGUE IN 2015 - SPONSORED BY THE PHYSIOLOGICAL SOCIETY

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#### MUSCLE FATIGUE: THE NEED FOR A TRANSLATIONAL APPROACH

Place, N.

*University of Lausanne*

The origin of the exercise-induced impaired muscle performance is a subject of debate in the scientific community. Whereas some studies indicate that failure proximal to the neuromuscular junction ("central fatigue") explains much of the impairment in muscle function, others show that processes distal to the neuromuscular junction ("peripheral fatigue") are of great importance. This talk will present the tools used to study neuromuscular adaptations in humans and will use examples from the literature to illustrate the task dependency of muscle fatigue (1). It will also be emphasized that the mechanisms underlying muscle fatigue may also depend on the criteria used as indexes of fatigue (e.g. time to task failure vs. reduction in maximal voluntary contraction force) (2). Finally, the presentation will discuss the usefulness of combining animal and human approaches (intact single muscle fibres vs. exercising humans) to get a better understanding of muscle fatigue processes (3). It will be shown that this kind of approach can be useful to get insights into the methods used to study muscle fatigue, such as the twitch interpolation technique widely used for central fatigue assessment (4). REFERENCES 1 Neyroud D, Rüttimann J, Mannion AF, Millet GY, Maffiuletti NA, Kayser B, Place N 2013 J Appl Physiol 114:1426-34, 2 Neyroud D, Maffiuletti NA, Kayser B, Place N 2012 Med Sci Sports Exerc 44:1243-51 3 Place N, Yamada T, Bruton JD, Westerblad H 2010 Eur J Appl Physiol 110:1-15 4 Place N, Yamada T, Bruton JD, Westerblad H 2008 J Physiol 586:2799-805

#### MUSCLE FATIGUE: THE CONTRIBUTION OF MOTONEURONAL FACTORS

Gandevia, S.C., Taylor, J.L.

*Neuroscience Research Australia*

Key determinants of the force produced by a muscle's contraction are the voluntary firing of its motoneurons and the force generated by the muscle fibres innervated by the motoneurons. Fatigue develops when muscle fibres are driven for long periods or at high rates (i.e. maximal force-generating capacity declines). In healthy limb muscles much of this occurs due to processes distal to the neuromuscular junction (i.e. peripheral fatigue) (1). However, central processes also limit force in voluntary contractions (2). In many exercise situations there is 'supraspinal' fatigue (i.e. a failure to generate sufficient output from the motor cortex). Much evidence indicates that when voluntary force declines, motoneuron firing rates are not sustained at sufficiently high rates or motoneurons stop firing altogether. The presence of supraspinal fatigue has been documented with cortical stimulation in many tasks. While this shows that cortical and motoneuronal output are both suboptimal, the mechanisms are not straightforward. Recent work using techniques to silence motoneurons transiently has highlighted novel processes that reduce 'gain' at the motoneuron during voluntary contractions (e.g. 3) while other studies using antidromic activation have revealed that strong voluntary contractions produce an activity-dependent reduction in motoneuron excitability measured as the capacity to produce a recurrent discharge (e.g. 4). Such processes will accompany muscle fatigue and increase the voluntary synaptic input needed to generate motoneuron output. 1 Allen DG, Lamb GD, Westerblad H 2008 Physiol Rev 88: 287-332 2 Gandevia SC 2001 Physiol Rev 81: 1725-89 3 McNeil CJ, Martin PG, Gandevia SC, Taylor JL 2009 J Physiol 587: 5601-12 4 Khan SL, Giesebrecht S, Gandevia SC, Taylor 2012 J Physiol 590: 4957-69

#### MUSCLE FATIGUE: THE POTENTIAL CONTRIBUTION OF MUSCULAR FACTORS

Westerblad, H.

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The ability to contract becomes impaired when muscles are driven for long periods or at high rates, i.e. fatigue develops. The impaired contractile function in fatigue is to a large, but variable, extent due to factors within the muscle fibres, i.e. peripheral fatigue (1). Fatigue-induced impairments in muscle fibres initially affect myofibrillar function, causing reduced cross-bridge force production and decreased Ca<sup>2+</sup> sensitivity. Subsequently when fibres start to reach exhaustion, force is further reduced due to decreased Ca<sup>2+</sup> release from the sarcoplasmic reticulum (SR). Interestingly, fatigue can induce long-lasting decreases in myofibrillar Ca<sup>2+</sup> sensitivity and/or SR Ca<sup>2+</sup> release. The relative extent of these two force-depressing mechanisms depends on the cellular handling of reactive oxygen/nitrogen species (ROS/RNS)(2). ROS/RNS also seem to have key roles in the fine-tuned balance between positive effects of endurance training vs. detrimental effects observed with overtraining (3). The proposed presentation will summarise mechanisms underlying the acute and prolonged fatigue-induced impairments and their relation to training-overtraining. REFERENCES 1. Allen DG, Lamb GD, Westerblad H. 2008 Physiol Rev 88: 287-332 2. Cheng, A.J., Bruton, J.D., Lanner, J.T. & Westerblad, H. 2015 J Physiol 593, 457-472 3. Ivarsson N, Bruton JD, Westerblad, H. 2011 Physiol News 83, 18-20

## Invited symposia

### IS-SH10 URBAN SPORT LANDSCAPES

#### 'GLOCAL' URBANISATION – SPORT'S POWER OF POSITION

Westerbeek, H.

VICTORIA UNIVERSITY

The sporting industry has never been more global, in an era during which the perceived value of the few hallmark sporting events that reach out to the whole planet cannot be overstated. Ironically in that context of global expansion, sport is increasingly argued to remain a product that is best locally consumed. As a product that is universally understood in regard to its rules, but locally produced (other than cyber-sport) in context of culture and physical surroundings, it offers tremendous scope to draw in the global in order to sell the local. This glocalisation can be explored from a number of perspectives. An interesting starting point is the increasingly prominent place of the city as a means to position nations, nationalities, cultures, and corporate capacity. In this presentation we explore the various angles that city and brand marketeers can take in their efforts using sport activities, sport identities, sport facilities, and sport performance to promote and position their brand and destination. Some initial findings from the Global Sport Impact project will be presented. References Allen D, Knott, B, Swart, K. (2013). *the International Journal of the History of Sport*, 30(16), 1994-2006. Grix, J. (2012). *Journal of Sport and Tourism*, 17(4), 289-312. Knott, B, Fyall, A, Jones, I (2013). *Journal of Hospitality Marketing and Management*, 22(6), 569-595. Westerbeek, H, Linley, M. (2012). *Journal of Brand Strategy*, 1 (2), 193-205. Contact hans.westerbeek@vu.edu.au

#### ACTIVATING AND INCLUDING DOGMA ARCHITECTURE IN URBAN SPACE

Kural, R.

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Introduction In 2012 conducted Centre for Sports and Architecture, Denmark, a major intervention project in a socially deprived area, Haraldsgade. Three installations were designed to generate physical activity among groups usually excluded from urban space: Girls, women, young children, seniors and people of different ethnic origin. The starting point was to obtain new knowledge about whether physical environments can help to promote the physical and spontaneous activity in the public sphere. The hypothesis was that the design of urban space can influence people to be more physically active in everyday life while increasing their joy of living and quality of life. On this basis, we constructed the installations in three remaining areas, three street corners, so they did not take up space in the already dense neighborhood. Methods The design work was done in relation to seven value concepts. The concepts derived from scientific studies, and - where they do not exist - from guidelines, manuals and programs from practice. (3). The value concepts were: 1. visibility, 2. availability, 3. security, 4. shelter, 5. spectators, 6. identity and 7. aesthetics. Observational studies: in 16 days in spring and autumn 2012, eight students conducted 2 x 768 observations of 15 minutes. On a plan of the area they signed in the gender of those who used the facilities, what they did, their age, activity level and position in space. During the observation period, more than 7000 people used the installations. Results and discussion The results showed that a broad section of the neighborhood's very complex population across age, gender, race, creed and origin, had used them - though not senior citizens (1). Similar studies show that when urban spaces are open spaces for activity, they are often taken over by boys and men, while girls and women are looking to the periphery, which the activities can be observed (2). The same was true with the installation, seven swings, designed for girls and women. The observations showed that on this installation it was teenage girls and women who seized the social and spatial control. Referencer (1) Center for Idræt og Arkitektur. Sundhedsfremmende arkitektur. Observationsstudier i Haraldsgadekvarteret forår og efterår 2012. Det kongelige Danske Kunstakademis Skoler for Arkitektur, Design og Konservering, Center for Idræt og Arkitektur, 2013-14. (2) functional, visual and semiotic openness. *Geographica Helvetica* Jg. 64, 2009/heft 1, pp. 21-29. (3) Se f.eks. Statens folkehølsinstitutt. Aktivt liv i byggede miljøer. Manual for kommunal planering. Statens folkehølsinstitutt, Östersund, 2010, og Sveriges Kommuner och Landsting & Riksidrotts Förbundet. Spontanidrottsanläggningar och miljöer. En utmaning för samhällsplaneringen. Sveriges Kommuner och Landsting & Riksidrotts Förbundet, 2011. Contact E: rene.kural@kadm.dk

#### PLANNING FOR ACTIVITY – LINKING PHYSICAL ACTIVITY TRENDS AND URBAN DEVELOPMENT TRENDS

Book, K.

*Malmö University*

This presentation takes as point of departure a number of physical activity and sporting trends in Sweden, but also other Western World countries. The trends highlighted, are of an everyday and non-elite character and include among others: Decreased interest in organized sport activities, increased interest in flexible, individual and self-organized activities as well as activities provided by commercial actors, the rise of 'new' activities like parkour and lifestyle sports and a growing activity segregation. A common feature of these activities is a need for other (urban) environments than ordinary sports facilities. This paper analyses the new physical activity trends in the light of urban development and planning, using research results and examples from different cities. The presentation has a conceptual and comprehensive character using results mainly from three research projects conducted by Karin Book: -The role of sport in urban planning: This project deals with the perception of sport and its role and place in urban planning in Sweden. The starting point of this project is on the one hand the changing conditions for planning including for instance increased focus on densification and infill strategies as well as new solutions for integration of different functions. And, on the other hand it is the changing conditions for the sports movement and how sport is carried out. -Motions in the city. Physical Activity and Mobility in a Segregated City: This project deals with the activity level and geographical/territorial range in connection to physical activity among adolescents in three residential areas with different spatial and socio-economic characteristics in Malmö, Sweden. Moreover, the project deals with the planning of different types of physical-activity places in ordinary, everyday environments, in which many adolescents spend their leisure time. -Running out of time? Strategies and perceptions in connection to physical activity: This project concerns perspectives on time use and perception and strategies for physical activity with basis in the following research question: how, when and where do employed people (in Sweden), age 30-50, find time and space for physical activities? This project highlights both exercise trends among the adult population and the role of the spatial context. These projects are connected under the heading of planning for activity.

## Invited symposia

### IS-SH08 CHILDRENS RIGHTS IN SPORT

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#### CHILDREN'S RIGHTS VS. ELITE SPORT DEVELOPMENT

Donnelly, P.

*University of Toronto*

Several commentators have pointed out that some 16 to 18 Articles of the UN Convention on the Rights of the Child are routinely or occasionally violated by those involved in the training of talented child athletes. The current structures of organized sports in many countries – authoritarian, control-based coaching; instrumentalization of the athlete's body; and a single-minded focus on sport development at the expense of social and educational development – are behind these violations of children's rights. Given that it is appropriate to nurture and develop talented children in any area their talent, and given that it is crucial to honour the rights of children, this (proposed) paper asks whether it is possible to encourage talent development in children with evident sports skills while also ensuring the protection and development of the whole child. The paper will also explore, in a preliminary way, the conflicted role of parents in nurturing the development of talented children, particularly the dilemma between ambition and protectiveness.

#### CHILDRENS RIGHTS IN SPORT - A SWEDISH PERSPECTIVE

Redelius, K.

*The Swedish School of Sport and Health Sciences*

**Introduction** In an attempt to ensure a more child centered approach, the Swedish Government decided in 2009 that if sports clubs were to receive state funding for children's sports the adoption of a child's perspective was essential. This means that sports coaches have to follow the United Nation's Convention on the Rights of the Child. However, being a sports coach for children is a complex and responsible task and often involves balancing various stakeholders' quests for sporting performance and results. In many ways, coaching children can be described as a tension between doing what is necessary in order to succeed and doing what is best for the child. Although many countries have adopted similar policies in order to protect children who are engaged in sport, there are few studies about what this means in practice. **Aim** The aim of the study presented was to investigate Swedish sports coaches' ideas and understandings of what a children's rights' perspective means in the sporting context. A starting point is the inherent strain, especially in youth sports, between conflicting discourses about competition and health. Central questions are: 1) What rights do children have in sport according to coaches? 2) How are these rights honoured in the sporting practice? And 3) How do coaches handle conflicting ideas about what is best for the sporting child? **Method** The empirical material draws on data collected through questionnaires and in-depth interviews. There were 160 coaches (111 men and 49 women) from 29 different sport federations who responded to the questionnaire. Moreover, 12 coaches (7 men and 5 women) from both individual and team sports were interviewed. All the coaches worked voluntarily for their club. Some were beginners and some had over 30 years of experience of being a coach. On the average they had coached children's sport for six years. The results from the questionnaire were analysed using Statistical Package for the Social Sciences, version 19. A content analysis of the responses from the interviews was conducted, from which emerged identifying patterns or descriptive findings concerning the coaches' perceptions of child rights. These were then assigned to different categories. **Results** The results show that coaches have limited knowledge and poor understanding of what a child right's perspective means and how it can be exercised in the sporting practice. In order for children to engage in healthy lifestyles beyond school and sustain this involvement over time, it is important to enhance coaches' awareness about children's rights in sport.

## Oral presentations

### OP-PM21 Physiology: Respiration

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#### BREATH-BY-BREATH GAS EXCHANGE AT ALVEOLAR LEVEL: AN ALTERNATIVE IDENTIFICATION OF START AND END-POINTS OF THE RESPIRATORY CYCLE

Francescato, M., Cettolo, V.

*University of Udine*

**INTRODUCTION** Computation of the gas exchange on a breath-by-breath (BbB) basis is traditionally performed assuming that the respiratory cycle starts at the onset of inspiration and ends when expiratory flow had entirely or largely ceased (Auchincloss et al. 1966). Whenever the gas exchange is to be estimated at alveolar level, a correction for the changes in the pulmonary gas stores is also required, which implies the knowledge of the alveolar volume at the start of the breath. Grønlund (1984) circumvented this problem by proposing a new timing of the respiratory cycle, where the start and end points have equal expiratory gas fractions, despite several different time intervals are associated with the same cycle. An alternative timing of the respiratory cycle, which halves the number of time intervals associated with each breath, is here described and evaluated in comparison to the algorithm proposed by Grønlund (1984). **THEORY** The start and end points of each respiratory cycle can be identified as the times in successive breaths where identical ratios between O<sub>2</sub> (or CO<sub>2</sub>) and N<sub>2</sub> fractions (i.e. FO<sub>2</sub>/FN<sub>2</sub> or FCO<sub>2</sub>/FN<sub>2</sub> ratios) are observed towards the end of the expiration. This alternative timing of the respiratory cycle continues circumventing the need to know the alveolar volume at the start of the breath while resulting in only two time intervals for each breath: one for O<sub>2</sub> uptake and one for CO<sub>2</sub> release. **METHODS** Oxygen and carbon dioxide fractions, and ventilatory flow at the mouth were continuously recorded in 20 subjects (11 M; 9 F) over 6 min at rest and during a cycloergometer exercise including 4 increasing intensities (0.6, 0.9, 1.1, and 1.4 W/kg body mass) lasting 6 min each. Computerised procedures were developed in C language to implement the two algorithms at stake, using as far as possible the same routines, allowing us to compute alveolar BbB oxygen uptakes from the gas and flow traces applying both Grønlund's and the new method. **RESULTS** We analysed 14257 breaths, with an average breath frequency of 21.6±5.3 breaths/min among subjects. The data obtained with the two methods were close to the identity line (average slope 0.998±0.004; R>0.994; n>334 in all subjects). Average difference between the O<sub>2</sub> uptake data obtained by the two

methods amounted to  $-0.27 \pm 1.29$  mL/min, while the standard deviation of the differences was  $11.5 \pm 4.6$  mL/min. The relative percentage difference was independent from the O<sub>2</sub> uptake and showed an average bias among subjects close to zero ( $-0.06 \pm 0.15\%$ ). CONCLUSIONS The ratio FO<sub>2</sub>/FN<sub>2</sub> (or FCO<sub>2</sub>/FN<sub>2</sub>) amplified the signal changes as compared to the simple gas fractions, making the identification of the start and end times of the breaths more robust. The alternative timing of the respiratory cycle provided congruent O<sub>2</sub> uptake data without introducing systematic errors. REFERENCES Auchincloss JH, Jr, Gilbert R, Baule GH (1966) *J Appl Physiol* 21:810-818 Grønland J (1984) *Eur J Appl Physiol* 52:167-172 CONTACT maria.francescato@uniud.it

### THE EXCESS VO<sub>2</sub> AND THE SLOW COMPONENT OF OXYGEN UPTAKE KINETICS

Oueslati, F., Tabka, Z., Ahmaidi, S.

APERÉ (EA-3300), University of Picardie Jules Verne, Amiens, France.

1: APERÉ (Amiens, France), 2: UR12ES06 (Sousse, Tunisia) Introduction During incremental exercise, it is generally believed that VO<sub>2</sub> increases proportionally to power output (PO). However, above the anaerobic ventilatory threshold (VT), it has been shown that the VO<sub>2</sub>/PO increases non-linearly characterizing the excess of VO<sub>2</sub> ( $\Delta$ VO<sub>2</sub>). During a constant high exercise intensity (CE), the VO<sub>2</sub> shows a continuous increase until the end of the exercise, the slow component of VO<sub>2</sub> (A2VO<sub>2</sub>). The explanations given to the both phenomenon are usually attributed even to an increase in work of respiratory and/or locomotor muscles (Zoladz & Korzeniewski 2001). Therefore, the aim of this investigation was to study (i) the relationship between  $\Delta$ VO<sub>2</sub> and A2VO<sub>2</sub>, (ii) the impact of each exercise on the respiratory muscles strength (iii) the muscular slow component of VO<sub>2</sub> (A2HHb) assessed from HHb kinetic in vastus lateralis using NIRS, and their relationship with A2VO<sub>2</sub>. Methods Fourteen male cyclists performed a maximal incremental exercise (MIE) and CE at 85% of VO<sub>2</sub>max on a cycle ergometer with measurement of maximal inspiratory (MIP) and expiratory (MEP) pressure before and after each exercise.  $\Delta$ VO<sub>2</sub> corresponds to the difference between VO<sub>2</sub>max observed and VO<sub>2</sub>max expected at maximal aerobic power using the linear relationship between VO<sub>2</sub> and PO below the VT ( $VO_2 = a \times PO + b$ ) during MIE. The slow component of HHb (A2HHb) and the A2VO<sub>2</sub> correspond to the difference between their values at 3' and the end of CE. Results Results show that A2HHb was related to A2VO<sub>2</sub> ( $r=0.7$ ;  $p<0.01$ ). However, no relationship was observed between A2VO<sub>2</sub> and  $\Delta$ VO<sub>2</sub>. MIP and MEP respectively decrease by 5.2% and 11.5% ( $p<0.01$ ) after MIE, and by 19.5% and 17.6% ( $p<0.05$ ) after CE. These decline observed after CE was related to the A2VO<sub>2</sub> (MIP,  $r=0.7$  and MEP,  $r=0.5$ ;  $p<0.05$ ). Discussion The main finding of the current study highlighted the absence of relationship between the A2VO<sub>2</sub> and  $\Delta$ VO<sub>2</sub>. Although the implications of respiratory and peripheral muscles are valid for both phenomenon, but differently. The decline of MIP and MEP are greater after CE than MIE showing that the involvement of respiratory muscles is deferent. In addition, above VT fast twitch fibers (IIa) are recruited during MIE, and consume more O<sub>2</sub> than slow twitch (Krustrup et al., 2008). However, Zoladz et al. (2008) reported that the progressive recruitment of muscle fibers is not necessary for the A2VO<sub>2</sub>, which may be caused by the metabolic factors that induce muscle fatigue and, as a consequence, reduce the efficiency of muscle contractions. Results indicate that VO<sub>2</sub> kinetic reflect the change of deoxyhemoglobin in vastus lateralis during a CE. References Krustrup P, Secher NH, Relu MU, Hellsten Y, Söderlund K, Bangsbo J (2008) *J. Physiol.* 586:6037–6048 Zoladz JA, Gladden LB, Hogan MC, Nieckarz Z, Grassi B. (2008). *J Appl Physiol*, 105:575–580 Zoladz JA, Korzeniewski B. (2001). *J Physiol Pharmacol*, 52:167–184 Contact oueslati.ferid@hotmail.com

### OVERESTIMATE OF RELATIVE AEROBIC CONTRIBUTIONS WITH MAXIMAL ACCUMULATED OXYGEN DEFICIT IN ADOLESCENT FEMALE KAYAKERS

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Shanghai University of Sport

Introduction Previous investigators have demonstrated a variety of values of relative aerobic contributions (WAER%) in Olympic kayaking (e.g. 29-40% in 200m, and 57-69% in 500m). The methods utilized to calculate the energy contributions may be one cause of these different values. The aim of this study was to compare the WAER% calculated with two different methods in simulated 200m and 500m kayak racing. Methods Eleven adolescent female kayakers ( $14 \pm 1$  yrs,  $172 \pm 4$  cm,  $65.4 \pm 4.2$  kg,  $42.6 \pm 4.9$  mL $\cdot$ min $^{-1}$  $\cdot$ kg $^{-1}$ ) volunteered to participate in this study. The kayakers performed an incremental test and two time trials on a kayak ergometer (Dansprint, Denmark) on separate days, with at least 24-h rest in between. The incremental test consisted of four to six 5-min steps with 1 min interruption in between, starting from 40 watts with an incremental of 15 watts. The two time trials lasted 40s and 120s to simulate the 200m and 500m racing, respectively. A portable spirometric system (MetaMax 3B, Germany) was utilized to measure the gas metabolism throughout all the tests. 20  $\mu$ L was taken after each step in the incremental test, and before and after the time trials, and was later assessed with a lactate analyzer (Biosen S\_line, Germany). Two methods were utilized to calculate the energy contributions during the time trials. The first was the maximal accumulated oxygen deficit (MAOD) (Medbo et al. 1988). The second was based on the fast component of oxygen debt after the exercise (Pcr-La-O<sub>2</sub>) (Beneke et al. 2002). The WAER% between the two methods was compared using two-tail paired t-tests. A type-I error rate was set at 0.05. Results MAOD induced higher WAER% than Pcr-La-O<sub>2</sub> during the 40s ( $36.1 \pm 3.7\%$  vs.  $30.6 \pm 3.5\%$ ) and 120s ( $60.7 \pm 12.2\%$  vs.  $57.5 \pm 4.5\%$ ) time trials, and the difference in the 40s time trial was significant ( $p<0.05$ ). Discussion The primary findings in this study were the overestimate of WAER% with MAOD compared with that with Pcr-La-O<sub>2</sub> in kayaking time trials, especially when the intensity was higher (i.e. 40s). This was consistent with our previous literature review (Li et al. 2014) and other challenges for MAOD (Bansbo 1992). Although MAOD is the most popular method in calculating energy contributions in exercise/sports (Li et al. 2014), the theoretical basis of MAOD has some limitations, including the linear correlation between the intensity and VO<sub>2</sub> and the ignorance of the anaerobic energy contribution during exercises under a sub-maximal intensity (35-90% of VO<sub>2</sub>max). These limitations might lead to an underestimate of the anaerobic energy contribution, and then an overestimate of WAER%. However, it is still open for research to investigate which method provides a value closer to the nature. References BANGSBO, J. (1992). *J Appl Physiol*, 73(3), 1207-1209. Beneke et al. (2002) *Eur J Appl Physiol*, 87(4), 388-392. Li et al. (2014). *J Sports Med Phys Fitness (E-pub First)*. Medbo et al. (1988). *J Appl Physiol*, 64(1), 50-60.

### ACUTE INSPIRATORY LOADING DOES NOT IMPROVE 2.4 KM TIME-TRIAL PERFORMANCE WITH A 25 KG THORACIC LOAD

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Purpose: The addition of an inspiratory muscle warm-up (IMWU) to active warm up (AWU) has demonstrated increases in performance on maximal exercise tasks. This is attributed to the priming of the respiratory musculature prior to exercise attenuating exertional dysp-

noea, lactate accumulation and respiratory muscle fatigue. To date, these observations have been made in sporting activities; however, when wearing a backpack such as in physically demanding occupations. Wearing such loads alters breathing mechanics, replaces a volume limitation upon the thoracic cavity, heightens the work of breathing and leads to premature fatigue of the inspiratory muscles group; ultimately impairing whole body performance. Therefore, it is attractive to suggest that acute inspiratory loading could improve performance in this exercise mode; however this remains unknown. Methods: Participants (n= 9) performed five 2.4km time-trials with a 25kg thoracic load in a backpack on separate days preceded by either 1) IMWU, 2) AWU, 3) placebo IMWU (PLA), 4) AWU followed by IMWU and 5) AWU followed by PLA. IMWU comprised two sets of 30 inspiratory efforts against a pressure threshold load of 40% of maximal inspiratory pressure (PIMAX) measured prior to each trial. PLA trials comprised five min quiet breathing against a sham device with no resistance. No resistance was favoured of smaller resistances to negate increased diaphragm excitability, observed when using lower resistances. AWU comprised 10min unloaded exercise at lactate turn point ( $10.33 \pm 1.58 \text{ km}\cdot\text{h}^{-1}$ ). All AWU components were conducted prior to IMWU and PLA. Results: Time-trial performance was similar between all trials (IMWU:  $14.32 \pm 1.34 \text{ min}$ , AWU:  $14.40 \pm 2.28 \text{ min}$ , PLA:  $14.77 \pm 1.92 \text{ min}$ , IMWU+AWU:  $14.14 \pm 1.74 \text{ min}$  and PLA+AWU:  $14.68 \pm 2.15 \text{ min}$ ;  $P > 0.05$ ) although performance for IMWU and AWU+IMWU were quicker than PLA trials this was not statistically significant ( $P > 0.05$ ). All respiratory, ventilatory, physiological and perceptual responses were also similar between trials. Conclusions: The addition of a specific IMWU to an existing AWU did not increase performance during a 2.4km time-trial when wearing a 25kg backpack; we suggest that AWU consisting of moderate intensity exercise for 10 min was sufficient in preparing the inspiratory musculature for high-intensity exercise with thoracic loading, without the need for specific priming of inspiratory muscles.

### MODELING INTERMITTENT CYCLING PERFORMANCE IN HYPOXIA USING THE CRITICAL POWER CONCEPT

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Purpose: Recently, a novel model derived from the critical power (CP) concept was developed to determine  $W'$  balance ( $W'$ BAL) during variable intensity exercise. The purpose of this study was to investigate the effect of hypoxia on the efficacy of the  $W'$ BAL model during high-intensity intermittent exercise. Methods: Eleven trained, male cyclists (mean $\pm$ SD; age  $27 \pm 6.6$  years,  $\text{VO}_2\text{peak}$   $4.79 \pm 0.56$ ) completed a maximal incremental ramp test and a 3 min "all out" test to determine end power (EP) and work performed above EP ( $W'$ EP). On another day an intermittent test to task failure was performed. All procedures were performed in normoxia (NORM) and hypoxia (HYPO;  $\text{FiO}_2 = 0.155$ ). The experimental condition was single-blinded, randomized and counter-balanced, and the  $W'$ BAL model was used to calculate the minimum  $W'$  ( $W'$ BALmin) achieved during the intermittent test.  $W'$ BALmin in HYPO was also calculated using model parameters derived in NORM (N+H). Results: In HYPO there was a significant decline in  $\text{VO}_2\text{peak}$  ( $4.79 \pm 0.56$  vs  $3.93 \pm 0.47 \text{ L/min}$ ;  $P < 0.001$ ) and EP ( $353 \pm 46$  vs  $319 \pm 49 \text{ W}$ ;  $P < 0.001$ ), whereas no change occurred for  $W'$ EP ( $12.6 \pm 4.1$  vs  $13.3 \pm 5.3 \text{ kJ}$ ;  $P = 0.34$ ; NORM vs HYPO). The change in  $\text{VO}_2\text{peak}$  was significantly correlated with the change in EP ( $r = 0.72$ ;  $P < 0.05$ ). There was no difference between NORM and HYPO for  $W'$ BALmin ( $1.7 \pm 0.9 \text{ kJ}$  vs  $1.3 \pm 0.8 \text{ kJ}$ ). The N+H analysis revealed a gross overestimation of  $W'$ BALmin ( $8.3 \pm 3.2 \text{ kJ}$ ) and compared with HYPO ( $P < 0.001$ ). Conclusion: The  $W'$ BAL model behaves similarly in hypoxic conditions equivalent to  $\sim 2450 \text{ m}$  as previously reported for normoxia, but only when the model parameters (CP and  $W'$ ) are determined under the same environmental conditions. The practical application of the  $W'$ BAL model for altitude training and performance monitoring requires CP and  $W'$  to be measured at altitude.

## Oral presentations

### OP-BN04 Running

#### THE INTERACTION BETWEEN NEUROMUSCULAR RESPONSES AND INITIAL LOADING RATE IN ELITE KENYAN RUNNERS

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*University of Cape Town*

Introduction: Loading rate has been proposed to be a risk factor for stress fracture when running. Previous research has suggested that muscle activation strategies and resultant kinematics prior to initial ground contact influence loading rate<sup>1,2</sup>. Studying various trained groups may provide insight into the muscle activation strategies related to modifying the loading rate and running injury risk factors. Methods: Fourteen elite Kenyan ( $24 \pm 4.1$  years &  $28.7 \pm 0.4 \text{ min}$  10-km race time) participated in this study. Ground contact forces (AMTI Watertown, USA) and electromyography (Noraxon, Arizona, USA) of medial and lateral gastrocnemii, peroneus longus, tibialis anterior, rectus and biceps femoris and gluteus medius muscles were measured at 12 km/h (warm-up) and 20 km/h (race pace) in both shod and barefoot conditions. Results: Condition differences were found between all muscles during pre-activation except peroneus longus and rectus femoris. Ground contact condition differences were found in lateral gastrocnemius, tibialis anterior, biceps femoris and gluteus medius. Differences in activity related to running speed in the Kenyan runners were only found in the medial gastrocnemius. Increased lateral gastrocnemius activity during stance were positively associated with initial loading rate at all running speeds Discussion: These findings suggest that elite Kenyan runners will indeed respond differently between both barefoot and shod conditions. Further that the medial gastrocnemius pre-activity appears to be influenced by running speed that may also suggest it is not as active during slow running. The relationships found implicate that high initial loading rates are related to lateral gastrocnemius activity, which may indicate a stabilizing role in weight transfer.

#### BIOMECHANICAL 3D FIELD MEASUREMENTS OF TRAIL RUNNERS

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Introduction: Trail running, where you run on dirt roads, single tracks, rocks and in the mountains has increased in popularity during the last few years. Compared to flat running, trail running is more technical challenging as the running takes place over rocks, roots as well as firm gravel roads or slippery tracks in the forest. Also, trail running often includes very steep uphill and downhill sections where it is too steep to run for most runners. The difference between track running and trail running is therefore significant and it is likely that biome-

chanical and physiological characteristics are different in specialized track runners compared to specialized trail runners. Hence, the purpose of the present study was to investigate the biomechanical and physiological characteristics for specialized trail runners compared to track runners, while running a typical trail running track. Method: Nine professional runners (3 women and 6 men) were recruited to the study. First, the runners performed an incremental lab test to determine running economy and VO<sub>2</sub>max. Thereafter, the group was divided into trail running specialists and track runners (5 trail runners and 4 flat runners). Second, all runners were equipped with 16 Inertial Measurements Units, IMU (MyoMotion, Noraxon Inc., Scottsdale, AZ, USA) and pressure insoles (MotiCon GmbH, Munich, Germany). Kinematic data was collected at 200 Hz and pressure data at 50 Hz. Each subject performed a 10-15 min long warm up before the data collection. The track consisted of two laps on a 3.5 km long technical loop which included a total vertical climb of 850 m. Ten continuing running cycles were analyzed during running on flat single track, moderate downhill and steep downhill. The subjects had one minute of rest between the two laps where all systems were checked and adjusted if necessary. Results: The trail running specialist showed a trend to complete the two runs on average 59.3 s faster than the track runners as well as losing less time between the two runs compared to the track runners (54.0 s vs. 100.3 s. respectively). Step frequency and ground contact time were significantly higher during steep downhill running compared to flat- and moderate downhill running ( $p < 0.001$ ). Steep downhill running generated lower peak forces than flat running ( $p < 0.05$ ). No differences in step kinetics were observed between flat- and moderate downhill running. A trend to increased hip and knee flexion was observed in the trail running specialists compared to the flat runners. Discussion: The present study showed clear differences in step kinetics when running in undulating terrain. Experienced trail runners completed the two laps on average 59.3 s. faster, even though all subjects have comparable VO<sub>2</sub>max (53±3 mL/kg/min for women and 65±5 mL/kg/min for men). Trail runners showed better ability to adapt to the surface and the kinematic data show increased joint flexion in the lower joints which is considered to decrease leg stiffness and contribute to "Groucho" running.

### INFLUENCE OF SHOE TYPE AND FATIGUE ON RUNNING STYLE

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Introduction It is thought that a minimalistic running shoe (MIN) will encourage a forefoot strike pattern, thereby reducing external loading rates applied to the body [1]. It is unclear whether first-time use of such shoes will induce an acute change in running style. In addition, the effect of musculoskeletal fatigue on the running style is not clearly understood, and research until now has yielded conflicting findings. We aimed to study the effect of first time MIN use and fatigue after a prolonged running bout and any interaction on running style. Methods We used a pressure-sensitive insole device to measure the strike index (point of contact on the footsole with the ground, expressed as a percentage of total sole length) and spatiotemporal parameters of running. 26 recreational runners were tested using conventional (CONV) and MIN shoes before and after a prolonged running bout (~20% of habitual session duration) on a treadmill at their preferred running speed. The coefficient of variation was calculated and detrended fluctuation analysis performed to determine stride-to-stride variability and correlative patterns, respectively. Results No significant differences were found for strike index between CONV [25.7±14.6% (unfatigued) and 23.1±11.1% (fatigued)] and MIN [28.9±19.1% (unfatigued) and 26.7±17.6% (fatigued)]. Similarly, no spatiotemporal parameter differences were observed between shoe types or fatigue states. Stride-to-stride variability and correlative patterns did not differ significantly between shoe type or fatigue states. However, there was an overall trend towards less correlation between strides when using CONV ( $p = 0.075$ ). The interaction between the conditions was not significant. Discussion The non-significant differences observed between the shoe types suggest that recreational runners do not naturally adapt their running style with first-time MIN use. The trend towards less correlation in strike index between strides with CONV shoe use could suggest that runners are more comfortable making changes in their strike pattern, possibly due to the added overall cushioning and familiarity of this shoe type. Our runners were able to maintain their running style despite the fatiguing effect of the prolonged running bout. References 1. Rixe JA, Gallo RA, Silvis ML. The barefoot debate: can minimalist shoes reduce running-related injuries? *Curr Sports Med Rep.* 2012;11(3):160-5.

### RUNNING BAREFOOT INDUCES LOWER VERTICAL DISPLACEMENT COMPARED TO SHOD CONDITION

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Introduction Barefoot running was prominent for millions of years until modern shod running. Several studies reported that barefoot running is more economical (2 to 6%) compared to shod running (Hanson et al. 2011; Perl et al. 2012). We hypothesized that a lower vertical displacement per unit of distance traveled while running would be a possible mechanism that may explain the lower energy cost in the barefoot condition. Therefore, we investigated the differences in the vertical and medio-lateral displacement for a long time interval (i.e. two minutes) between barefoot and shod running. Methods Twenty one participants performed randomly two minutes long barefoot and shod running trials (two of each), at their preferred velocities on a treadmill. Vertical ground reaction forces were measured using a pressure plate (Zebris FDM), integrated in the treadmill. Further using six cameras of the Simi Motion system (190 Hz) we measured the 3D coordinates of 11 reflective markers positioned on the back of the participants. The displacements of the spine and the scapula were identified and analysed separately. The vertical spine (VSp), vertical scapula (VSc), medio-lateral spine (MLSp) and medio-lateral scapula (MLSc) displacements have been extracted from the 3D coordinates of the 11 markers. Results Lower displacements ( $p < 0.05$ ) were documented in the barefoot condition on VSp, VSc and MLSp but not in MLSc ( $p > 0.05$ ). The differences to the shod condition were 4.4%, 3.4% and 6% for VSp, VSc and MLSp respectively. Foot strike patterns changed significantly ( $p < 0.05$ ) towards the front of the foot and cadence increased ( $p < 0.05$ ) by ~2.5% in barefoot condition. The integral of ground reaction forces over time decreased significantly ( $p < 0.05$ ) by ~9.8% when barefoot. We found a decreased total contact time (~4.9%) and an increased total flight time (~20.0%) in the barefoot compared to the shod condition. Discussion We found a lower vertical displacement on VSp and VSc at the same running velocity in the barefoot compared to the shod condition supporting our hypothesis. The lower vertical displacement resulted from the lower vertical impulses of the ground reaction force in the barefoot condition. The lower vertical displacement during barefoot running might be an important mechanism affecting the energy cost of running. References Hanson N.J., Berg K., Deka P., Meendering J.R., Ryan C. (2011). *Int J Sports Med.*, 32, 401-406. Perl D.P., Daoud A.I., Lieberman D.E. (2012). *Med Sci Sports Exerc.* 44, 1335-1343.

**EFFECTS OF MENTHOL IN STOCKINGS ON SKIN TEMPERATURE AND THERMAL PERCEPTION DURING RUNNING**

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**INTRODUCTION** The use of menthol in sport garments has been observed to improve thermal comfort in sports (Gillis et al., 2010). The aim of the study was to analyze the effect of menthol, applied in stockings by padding, on skin temperature and thermal perception before, during and after running. **METHODS** 10 male runners (age [28 ± 5 years], weight [66 ± 5 kg], height [174 ± 6 cm], and weekly mileage [37 ± 12 km/week]) participated in the study. Runners carried out 2 laboratory tests (normal stockings [NORMAL] and stockings with menthol [COLD]). Menthol was applied by padding (AITEX- Textile Research Institute) in a concentration of 7% Menthol, 3% PVP, 35% ethanol, 55% water. The order of the tests was randomized. At each test participants ran for 10 minutes at 10 km/h followed by 10 minutes at 12 km/h. All tests were carried out in a moderate indoor environment: 22.2 ± 0.7°C and 36.7 ± 9.5% relative humidity. Skin temperature of eight regions of interest on the lower limb was measured using infrared thermography before running (after 10 minutes of adaptation at room temperature) and immediately after the running test. Temperature variation between both measurements was assessed. Perception of temperature and thermal comfort were measured using a 15-cm visual analogue scale before, during and after running. Differences between NORMAL and COLD test were analyzed with a repeated-measures ANOVA. **RESULTS** No differences were observed between conditions in temperature variation and thermal comfort ( $p>0.9$ ). Temperature variation in both conditions was 0.5±0.3°C and thermal comfort of COLD condition was 10.3±2.5 cm, 9.5±2.3 cm, and 9.7±3.1 cm before, during and after running, respectively. Thermal comfort of the NORMAL condition was 8.5±2.0 cm (before), 7.9±2.8 cm (during) and 9.3±2.5 cm (after). Before running, no differences between both conditions were observed in temperature perception ( $p=0.9$ ), but COLD condition was perceived cooler than NORMAL condition during running (COLD vs NORMAL: 5.7±3.4 vs 10.0±1.1 cm,  $p=0.03$ ) and after running (4.7±2.8 vs 8.8±1.7 cm,  $p=0.04$ ). **DISCUSSION** Skin temperature did not vary across conditions (COLD and NORMAL). Also, no differences in perception of thermal comfort were observed between stockings. These results may imply that the use of stockings with menthol do not influence skin temperature and comfort in a moderate environment. Similar results have been observed in warm and humid conditions (Barwood et al, 2014). However, athletes perceived a lower skin temperature with the use of the menthol stockings, so it could be beneficial for comfort during exercise in a warm environment. In conclusion, running in a moderate environment while wearing stockings with menthol was perceived cooler for runners without compromising their skin temperature or perception of comfort. **REFERENCES** Gillis DJ, House JR., Tipton MJ. (2010). *Eur J Appl Physiol*, 110(3), 609-618. Barwood MJ, Corbett J, White DK. (2014). *J Sports Med Phys Fitness*, 4(5), 595-604. **CONTACT** i.aparicio.gibd@gmail.com

**Oral presentations****OP-PM40 Training & Testing: Strength I****EFFECTS OF VARIOUS WARM-UP MODELS ON 1 RM LEG PRESS PERFORMANCE IN COLLEGIATE ROWERS**

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**INTRODUCTION** Strength was proved to be one of the limiting factors of rowing performance. Significant relationships between 1RM leg press and rowing performance were demonstrated (Akca, 2014). Determining the leg press 1 RM precisely as possible is crucial to optimize the training plan of rowers individually. The warm-up procedure is a critical factor which effect the precision of the 1RM tests (Bishop, 2003). Thus; the aim of this study was to compare leg press 1 RM performance after different warm-up protocols. **METHODS** In a randomized crossover fashion, 1 RM leg press performance were measured in 4 different occasions after different warm-ups using rowing ergometer. The combinations were as follows: 1.Constant Low Intensity (CLI): 15 minutes at the power output that corresponds to 40% of VO2Max. 2. Low Frequency Intermittent (LFI): 13 minutes at the power output that corresponds to 40% of VO2Max and two 15 seconds sprints with the intensity of 170% of the power output at VO2Max during the last 2 minutes. 3. Moderate Frequency Intermittent (MFI): 10 minutes at the power output that corresponds to 40% of VO2Max and five 15 seconds sprints with the intensity of 170% of the power output at VO2Max during the last 5 minutes. 4. High Frequency Intermittent (HFI): 5 minutes at the power output that corresponds to 40% of VO2Max and ten times 15 seconds sprints with the intensity of 170% of the power output at VO2Max during the beginning of every min. in the last 10 min. Intermittent sprints during protocols separated by 45 seconds of recovery at 40% of VO2Max. After general warm-up, subjects performed standardized specific warm-up protocol. HR, RPE and Lactate were measured before and after each warm-up. Mixed linear analysis was employed for statistical analysis, warm-up conditions were set as fixed factor while participants as a random factor. **RESULTS** 1RM leg press performance was found significantly better (aprox. 4%) after LFI protocol compared with others. **DISCUSSION** The performance improvement compared with other protocols after using LFI warm-up may be considered small (aprox. 4%); however, the improvements about 3-4% is similar to those observed in response to a long term strength training (Kraemer, 1997). Thus, the results of the present study are important for both practical and research environments. **REFERENCES** Akca F. Prediction of rowing ergometer performance from functional anaerobic power, strength and anthropometric components. *J Hum Kinet*, 2014; 41: 133-142 Bishop D. Warm up II - Performance changes to structure the warm following active warm up and how up. *Sports Med*, 2003; 33(7): 483-498 Kraemer WJ. The physiological basis for strength training in American football. *J Strength Cond Res*, 1997; 11(3): 131-142 **CONTACT** firatakca@gmail.com

**DO CLUSTER-TYPE REGIMENS OFFER A SUPERIOR ALTERNATIVE TO TRADITIONAL RESISTANCE TRAINING METHODS WHEN THE GOAL IS MAXIMAL STRENGTH DEVELOPMENT?**

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**Introduction** It is widely believed that 'strength-type' (STR) resistance training (RT) is a more effective way of improving maximal strength than 'hypertrophy-type' RT (HYP) however, research comparing these training methods is far from unequivocal (Nicholson et al., 2014). Furthermore, cluster training (CL) challenges the traditional way in which strength training sessions are designed although there is a paucity of research into this approach. Our main objective was to compare the adaptations resulting from STR, HYP and CL training over a

6 week period involving the back squat. Methods 46 trained males (age:  $21.8 \pm 2.6$  years; height:  $178.0 \pm 6.3$ cm; mass:  $81.1 \pm 8.8$ kg) were matched according to one repetition maximum [1RM] strength before being randomly assigned to one of 4 groups: a) STR: 4x6 reps, 85% 1RM, 900s total rest; b) HYP: 5x10 reps, 70% 1RM, 360s total rest; c) CL-1 4x6 reps, 85% 1RM, 1400s total rest; d) CL-2: 4x6 reps, 90% 1RM, 1400s total rest. Physiological and mechanical variables were measured before, during and after the workouts to investigate the acute training stimulus whilst similar techniques were employed before, during and after a 6 week intervention (2 sessions per week) to investigate the training effects. The findings were analysed using a two-way mixed ANOVA with significance set at  $p < 0.05$ . Results From an acute perspective, the STR and HYP workouts resulted in significantly greater reductions in repetition quality than the CL workouts ( $p < 0.05$ ). Furthermore, the STR and HYP workouts showed significant post-exercise elevations in blood lactate concentration ( $p < 0.001$ ). In terms of chronic responses, all four groups elicited significant increases (8-13%;  $p < 0.001$ ) in 1RM strength after training; however, the 1RM improvements were significantly greater for the STR ( $12.1 \pm 2.8\%$ ;  $p < 0.05$ ) and CL-2 ( $13.2 \pm 2.2\%$ ;  $p < 0.001$ ) groups than the HYP group ( $8.1 \pm 2.5\%$ ). Increases in isometric peak force, rate of force development, muscle activity and jump height were not significantly different between groups. Discussion The STR and CL-2 regimens represented the most favourable means of improving maximal strength. The effectiveness of the STR and CL-2 regimens underlines the importance of longer time under tension and greater impulse generation for strength development but does not support the importance of higher velocities which are often used to signify repetition quality. The findings highlight that CL regimens can offer similar performance enhancements to STR regimens so the decision as to which approach should be used lies with coaches. References Nicholson, G. et al., (2014) *J Str Cond Res*, 28, pp.3188-3199 Contact: g.nicholson@leedsbeckett.ac.uk

### NEUROMUSCULAR ADAPTATIONS TO SHORT-TERM RESISTANCE TRAINING WITH LINEAR AND DAILY UNDULATING PERIODIZATION IN ADOLESCENT ELITE JUDOKA

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Introduction Few studies have assessed neuromuscular adaptations and strength outcomes after short-term strength training periods in adolescent athletes (Blazevich et al., 2003). Furthermore, the influence of different periodization models on temporal changes of neuromuscular parameters during short-term training periods remains unclear. This work examined the temporal changes of muscle architecture, neural drive, and maximal upper- and lower body strength after two short-term strength training mesocycles with either linear or daily undulating periodization in adolescent judoka. Methods Eleven adolescent elite judoka (14.8 years, 5 males and 6 females) performed two 4-week strength training mesocycles (each with 12 training sessions) with either linear (LP) or daily undulating (DUP) periodization separated by a 7-week washout period (no training and competition). Training was performed as dynamic lifting and lowering of weights using squats, knee flexion curl, clean & jerk, snatch, bench press, barbell bench pull, and lat-pull down. The mesocycles were equated for intensity zones (50-90% of 1RM) that addressed the optimization of strength, power or velocity and the number of repetitions. Laboratory and 1RM testing were carried out at five different occasions: two times during the baseline (T1, T2), after the LP-mesocycle (T3), after the washout period (T4), and after the DUP-mesocycle (T5). At each testing occasion, isometric knee extensor and knee flexor MVC, EMG-estimated neural drive of the M. quadriceps femoris (QF), vastus lateralis (VL) muscle architecture, and 1RM values of all training exercises were measured. ANOVA with repeated measures was performed to analyze the temporal changes for all absolute study outcomes. Wilcoxon-comparisons were used to analyze the percentage changes for each outcome between the two mesocycles. Results Moderate ( $\Delta$  5.5- 13.5%), but significant ( $P < 0.05$ ) gains in knee extensor MVC, 1RM values, and VL-muscle architecture occurred during both mesocycles. Importantly, no significant differences for the percentage changes of any outcome were found between the LP- and DUP mesocycles. Discussion For strength training experienced adolescent judoka, both linear and daily undulating periodization were equally adept in improving VL-muscle architecture, QF-neural drive, and maximum upper-and lower body strength during two 4-week strength training mesocycles. These findings question the influence of stimuli-periodization during short-term training periods. References Blazevich, A.J. (2003). *Medicine & Science in Sports & Exercise*, 35, 2013-2022.

### EFFECTS OF DIFFERENT SPLIT TRAINING ROUTINES ON ACUTE NEUROMUSCULAR PERFORMANCE OF ELBOW FLEXORS IN TRAINED MEN

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Introduction Split resistance training routine has been recommended for intermediate and advanced resistance trained subjects in order to allow appropriate muscle recovery and maximize training volume within a training session (ACSM, 2009). A synergist muscle arrangement are usually recommended for split training routines (Monteiro et al., 2009). However, the performance of single-joint exercise (i.e. arm curl) could be affected by the prior multi-joint exercise (i.e. seated row) during a synergist split training routine session. Moreover, controlled studies on the effects of split training arrangement on neuromuscular performance are lacking. Therefore, the aim of this study was to investigate the effects of different split training routines (synergists vs. non-synergists) on training performance of elbow flexors in trained men. Methods Eighteen trained men ( $23 \pm 3$  years) randomly performed three training routines separated by 7 days: 1) Synergist routine (SN): 6 sets of 10 maximum repetitions (RM) at supinated row machine followed by 4 sets of 10RM of elbow flexors on isokinetic dynamometer, 2) Non-synergist routine (NS): 6 sets of 10RM of bench press on smith machine followed by 4 sets of 10RM of elbow flexors on isokinetic dynamometer, and 3) Control (CO): 4 sets of 10RM of elbow flexors on isokinetic dynamometer. The rest interval between sets was 2 min. Elbow flexors mean torque (MT), total work (TW) and the amplitude of electromyography signal (EMG) were measured during elbow flexors isokinetic exercise. Results MT were significantly lower during SN and NS routines when compared to CO routine (3.6 and 6.4%, respectively) ( $p < 0.05$ ). MT were also 2.8% higher in NS than SN routine ( $p < 0.05$ ). Moreover, TW were higher in CO routine compared to SN and NS routines (10.3 and 5.5%, respectively). TW were 5.0% greater in NS than SN routines. Additionally, EMG did not differ among split training routines ( $p > 0.05$ ). Discussion The main finding of the present study was that training performance and volume of the elbow flexors exercise was impaired when the split training arrangement was composed by synergist exercises. Considering that EMG was not different among split training routines, the impaired training performance of the elbow flexors observed during SN split training may be due to peripheral changes such as impaired excitation-contraction coupling, shift of  $Na^+$  and  $K^+$  concentration in intracellular and extracellular fluids reductions in  $Ca^{2+}$  release (Gentil et al., 2007). In conclusion, if one wants to maximize the neuromuscular performance using a split training routine, a non-synergist session (i.e. chest exercise before elbow flexors exercise) is recommended for trained subjects. Financial Support: FAPEMIG, CAPES, CNPq. References ACSM (2009). *Med Sci Sports Exerc*, 41(3), 687-708. Gentil P,



Oliveira E, Rocha-Junior VA, et al. (2007). *J Strength Cond Res*, 21(4), 1082-1086. Monteiro AG, Aoki MS, Evangelista AL, et al. (2009). *J Strength Cond Res*, 23(4), 1321-1326. jbfjunior@gmail.com

### **LOW-INTENSITY RESISTANCE TRAINING WITH SLOW MOVEMENT AND TONIC FORCE GENERATION INCREASES MUSCLE SIZE AND STRENGTH BUT NOT POWER**

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**Introduction** Low-intensity resistance training with slow movement and tonic force generation (LST) has been shown to be effective in increasing muscle size and strength (Tanimoto and Ishii 2006). However, it is unknown whether LST increases power output during fast movements, which plays substantial roles in various physical activities. We tested our hypothesis that LST would increase muscle size and strength but not necessarily power during fast movements due to task-specific adaptation to the training modality. **Methods** Sixteen young men were assigned to LST [50% one repetition maximum (1RM) load, 3 s lowering and 3 s lifting without relaxing phase, 10 reps; n = 9] or low-intensity normal speed (LN: 50% 1RM load, 1 s for lowering and 1 s lifting with 1 s relaxing phase, 10 reps; n = 7) group. Both groups underwent a parallel squat training program 3 sets/day, 3 days/week, for 8 weeks by the assigned methods. Before and after the training, the following variables were measured; muscle thickness of quadriceps femoris (30%, 50%, and 70% of the femur for rectus femoris and vastus intermedius, 50% for vastus lateralis and vastus medialis), isometric torque during maximal voluntary hip extension and knee extension, 1RM of squat, maximal lifting power from squatting position (load: body mass), maximal leg extension power (0.8 m/s), and vertical and counter-movement jump height. **Results** After the training, LN showed no changes in all variables. In LST, significant increases were found in the muscle thickness of rectus femoris (+7%) and vastus intermedius (+14%) at 70% of the femur, isometric torque during hip extension (+15%), and 1RM of squat (+9%), but there were no changes in lifting power, leg extension power, and vertical and counter-movement jump height. **Discussion** Significant increases in muscle size and strength in LST but not in LN would be due to longer time under tension and greater metabolic stress in LST than LN (Tanimoto and Ishii 2006). The reason why significant increases in muscle thickness were found only at 70% of rectus femoris and vastus intermedius may be explained by inter- and inner-muscle difference in activation level during exercise (Wakahara et al. 2013). Regarding no changes in maximal power, Tanimoto et al. (2009) reported that 13-weeks LST changed muscle activation pattern during force production to be tonic, which may have negative influence on power production. These findings together with the current results suggest that LST can increase muscle size and strength, but has little effect on power production during fast movements. **References** Tanimoto M et al. (2009). *J Strength Cond Res*, 23, 2367-2376. Tanimoto M and Ishii N. (2006). *J Appl Physiol*, 100, 1150-1157. Wakahara T et al. (2013). *Med Sci Sports Exerc*, 45, 2158-2165.

### **ACUTE EFFECTS OF SELF MYOFASCIAL RELEASE ON SINGLE LEG STABILITY AND VERTICAL JUMP: A PILOT STUDY**

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**Introduction:** Self myofascial release (SMR) with foam roller is very popular among athletes and trainers. Practitioners use it before the training session because it is documented that SMR increases the articular ROM but does not affect neuromuscular characteristics (Healey et al., 2014; MacDonald et al., 2015). Previous studies did not use an SMR protocol on all the lower limb muscles as often happens during the field practice. The aim of the study is to measure the acute effects of a whole lower limb SMR protocol on single leg stability and vertical jump performance. **Methods:** Eighteen young and sporty people (10 male and 8 female: 24.5±4.5 y-o; 167.2±9.4 cm; 62.1±10.3 kg) were involved in a single session protocol consisting of: brief warm up, CMJ test, single leg stability test, 20 minute of lower limb SMR procedure, CMJ test, single leg stability test. CMJ and single leg stability tests were performed respectively by 10 and 18 people. The SMR protocol lasted 60' for each of the following muscular districts: plantar fascia, calves, tibialis anterior, peroneals, hamstring, quadriceps, gluteus, adductors, tensor fasciae latae of both legs. CMJ performance was measured by using a Bosco's conductive device (TT Sport, San Marino Republic). Single leg stability was measured both in Open Eyes condition (OE) and in Closed Eyes condition (CE) by using a FreeMed 40x40 platform (Sensor Medica, Italy). A Student's T-Test was used to assess the difference pre-post SMR protocol. Statistical significance was set at p<0.05. **Results:** CMJ showed a 7% significant decrease (p=0.010) between pre (35.5±9.4 cm) and post (33±8 cm) SMR protocol. Single leg stability did not show any significant difference for the right leg both in OE and in CE condition, while showed just a little significant difference (p=0.041) for the left leg in OE condition for the anterior-posterior movement. **Discussion:** The study shows how a longer SMR protocol on all muscles of the lower limb does not alter the stability in OE and CE condition, but it can affect the vertical jump performance, maybe for a prolonged lying on the ground position, as well as static stretching. It is very important for trainers and athletes to take this result into consideration in programming the warm up session. This pilot study will be implemented with other future tests but it is recommended to insert a brief neuromuscular activation after the SMR procedures to avoid any lowering in explosive movements. **References:** Healey KC et al. (2014). *J Strength Cond Reserch*, 6, 28(1), 61-68. MacDonald GZ et al. (2015). *J Strength Cond Reserch*, 27(3), 812-819 Contact info@esercizioposturale.it

## **Oral presentations**

### **OP-PM54 Health & Fitness: Lifestyle III**

#### **OPTIMIZED BODY COMPOSITION FOLLOWING COMBINED ENDURANCE AND STRENGTH TRAINING ON ALTERNATING DAYS COMPARED TO SAME-SESSION COMBINED TRAINING IN MEN**

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**Introduction** Our previous study has shown that strength (S) and endurance (E) performance increase to a similar extent when S and E are performed on alternating days or consecutively in the same training session with different orders (1). However, split exercise sessions may result in increased EPOC (2) and, thus, changes in body composition following combined training on alternating days may differ from changes following S and E training performed in the same-session. Thus, the purpose was to compare adaptations in body composition during S and E training performed either on alternating days or in the same training session in men. **Methods** Physically active men were

assigned to an alternating-day (AD, n=21, BMI 25±3 kg/m<sup>2</sup>, 29±6yrs) or a same-session training group with E preceding S (ES, n=17, BMI 25±3 kg/m<sup>2</sup>, 30±6 yrs) or vice versa (SE n=18, BMI 24±2kg/m<sup>2</sup>, 30±4 yrs). Training volume was matched in all groups. Training was performed for 24 wks with a frequency of 2-3 weekly sessions of both E and S in AD and 2-3 weekly combined sessions in ES and SE. S-training focused on leg muscles (but also included upper body and trunk exercises) with loads of 70-95% of 1RM. E training consisted of steady-state and interval cycling of progressively increasing intensity and duration. Total body lean (TBL) and fat mass (TBF) were assessed by DXA. Dynamic leg press 1 RM and peak workload (Watts, Wmax) during a maximal incremental cycling test were measured. Subjects were asked to maintain their regular dietary intake. Results TBL increased similarly in all training groups (AD 4±3% p=0.011, ES 3±3% p=0.001, SE 3±2% p<0.001), while significant decreases in TBF were observed in AD only (-14±15%, p<0.001). A significant increase in bodyweight was observed in SE only (2±4%, p=0.05). All groups similarly improved 1 RM (AD 13±7%, ES 12±9%, SE 17±12%, all p<0.001) and Wmax (AD 21±11%, ES 13±9%, SE 16±7%, all p<0.001). Discussion This study showed that combined S and E training performed on alternating days is similarly effective in increasing TBL, when compared to same-session combined training. However, splitting S and E onto alternating days led to significant reductions in TBF, indicating that AD training may be more beneficial for simultaneously improving both body composition and performance compared to ES or SE. These findings suggest that healthy individuals can increase TBL following either training mode, while differences may be observed in reductions of TBF. References 1. Eklund et al. 2015 IJSM, 2. Almuzaini et al. 1998 Can JAP Contact daniela.eklund@ju.fi

### EFFECTS OF HIGH INTENSITY INTERVAL TRAINING AND STRENGTH TRAINING ON CARDIOVASCULAR RISK FACTORS IN WOMEN WITH POLYCYSTIC OVARY SYNDROME: A RANDOMIZED, CONTROLLED TRIAL

Almenning, I., Rieber-Mohn, A., Garnæs, K.K., Lundgren, K.M., Lovik, T.S., Moholdt, T.

*Norwegian University of Science and Technology*

Introduction Polycystic ovary syndrome (PCOS) is the most common endocrine disorder of reproductive-age women and a leading cause of infertility, affecting up to 20%. PCOS is also recognized as a metabolic disorder with increased prevalence of insulin resistance, dyslipidemia (Kim and Choi, 2013), and low-grade inflammation (Repaci et al, 2011). Further, endothelial function is found to be compromised in PCOS (Sprung et al, 2013). Taken together, this suggests that women with PCOS are at increased risk of cardiovascular disease. Our primary aim was to study effects of high intensity interval training (HIT) and strength training (ST) on cardiovascular risk factors in women with PCOS. Methods Thirty-one women with PCOS were randomized to: HIT (n=10), ST (n=11) three times/week for ten weeks, or a control group (n=10). We measured maximum oxygen uptake, endothelial function (flow-mediated dilation of the brachial artery), resting heart rate, and blood pressure. In blood, we assessed: reproduction-related hormones, homocysteine, high sensitivity CRP, glucose, insulin, adiponectin and leptin. We used Bonferroni-adjusted covariance analysis with baseline values as covariate and group as fixed factor to assess differences between groups. Results Maximum oxygen uptake improved only after HIT, by 3.7 ml/min/kg, (95 % confidence interval (CI) 2.62, 4.83), with significant between-group difference (p<0.01). After HIT, high-density lipoprotein cholesterol increased by 0.2 (95% CI, 0.02, 0.5) mmol/L, with between group difference (p = 0.04). Endothelial function increased significantly after HIT, by 2.0 (95% CI, 0.1, 4.0) %, between-group difference (p = 0.08). There was a trend towards decreased resting heart rate after HIT, by -4.6 (95% CI, -9.6, 0.5) beats/min. There were no significant changes in blood pressure, homocysteine, high-sensitivity C-reactive protein, adiponectin or leptin in any group. Body weight did not change. Discussion HIT, but not ST, for ten weeks improved some cardiovascular risk factors in women with PCOS, without change in body weight. HIT was well tolerated with good adherence to exercise in these women. To our knowledge, this is the first study finding increased HDL cholesterol after exercise training in PCOS. There is little prior evidence of effects of exercise cytokines in this population and our study indicate that adiponectin and leptin levels do not change after ten weeks of exercise in PCOS. References 1. Kim JJ and Choi YM (2013). *Obstetrics & gynecology science*, 56:137-142. 2. Repaci A et al (2011). *Molecular and cellular endocrinology*. 335:30-41. 3. Sprung VS et al (2013). *Clinical endocrinology*. Mar 2013;78(3):438-446.

### SIX WEEKS OF HIT INCREASES VO<sub>2</sub>MAX AND DECREASES VISCERAL FAT CONTENT IN ELDERLY

Dideriksen, S., Abildskov, C., Søgaard, D., Dehlbæk, M.S., Dela, F., Helge, J.W.

*Exercise laboratory*

Introduction High intensity training (HIT) improves aerobic capacity (VO<sub>2</sub>max) and decreases visceral fat content in overweight sedentary young individuals (Trapp et al, 2008; Gillen et al, 2013). The effect of HIT in overweight sedentary elderly has not yet been investigated and it is uncertain whether HIT can be tolerated by this group. The aim of this study was to investigate 6 weeks of HIT as an alternative training method for elderly individuals and the effect on VO<sub>2</sub>max and visceral fat content. Our hypothesis was that HIT can be applied to elderly individuals and lead to an increase in VO<sub>2</sub>max and a decrease in visceral fat content. Methods Seventeen healthy but overweight sedentary subjects (8 M/9 F, 62±1 years, BMI: 31±0.8 kg/m<sup>2</sup>) completed 6 weeks of supervised HIT, 3 days/week. Their training consisted of 5 x 60 s cycling at 137±4 % of maximal work load interspersed with 90 s recovery. Before and after the 6 weeks of HIT aerobic capacity was measured with an incremental VO<sub>2</sub>max test to exhaustion on a cycling ergometer and body composition by dual-energy X-ray absorptiometry (DXA) (GE Luna iDXA, Madison, WI, USA). Visceral fat content was calculated by an algorithm from the DXA data. Results 6 weeks of HIT increased (P<0.003) VO<sub>2</sub>max from 2.3±0.1 l/min to 2.5 ±0.2 l/min. Visceral fat content decreased (P<0.031) by 5.4±2.6 %. DXA scan data showed a decrease (P<0.04) in total body fat percentage (1.9±0.8 %) including a decrease in android (P<0.05) and gynoid (P<0.003) fat percentage (2.7±1.1 % and 3.3±0.9 %, respectively). Total body mass (pre: 89.6±2.8 kg, post: 89.0±2.9 kg, P=0.235), total lean body mass (LBM) (pre: 51.9±2.6 kg, post: 52.2±2.6 kg, P=0.31) and leg LBM (pre: 18.4±0.9 kg, post: 18.5±0.9 kg, P=0.44) were not different after training. Discussion This study demonstrates that elderly individuals can tolerate and complete 6 weeks of HIT. The training increased VO<sub>2</sub>max, and decreased visceral fat content and total fat percentage including android and gynoid fat percentage. These findings extend and support previous studies reporting an improved VO<sub>2</sub>max and body composition in young sedentary males and females in response to HIT. We did not find an overall increase in leg LBM, but in the male subjects the leg LBM, was increased (P<0.02), which indicates a possible gender specific difference in the response to HIT. In conclusion, HIT is a possible training method to improve VO<sub>2</sub>max and body composition in sedentary elderly subjects. Further studies are necessary to elucidate the mechanisms responsible to adaptations to HIT in elderly individuals. References Gillen JB, Percival ME, Ludzki A, Tarnopolsky MA, Gibala MJ. (2013). *Obesity*, 21, 2249-225. Trapp EG, Chisholm DJ, Freund J, Boutcher SH. (2008). *International Journal of obesity*, 32, 684-691. Contact Sofie G. Dideriksen: sofied@sund.ku.dk Carina V. Abildskov: carina@sund.ku.dk

### **REDUCING SITTING TIME THROUGH STRUCTURED EDUCATION: SUGGESTED INTERVENTION IMPROVEMENTS IDENTIFIED BY PARTICIPANTS AND WORKSHOP LEADERS IN PROJECT STAND**

Biddle, S.

*Victoria University*

**Introduction.** Substantial portions of the day are spent sitting and this has been shown to have deleterious effects, particularly for cardio-metabolic health. Project STAND was a 12m RCT using structured education to reduce sitting. Results were mixed, but with some indication of small positive intervention effects. **Methods.** Participants taking part in STAND were younger adults at risk of diabetes. They were invited to attend a 3-h structured education workshop on sedentary behaviour and diabetes. They were interviewed 6 weeks after the workshop (n=45) and at the conclusion of the 12 month trial (n=10), as were two workshop leaders. We probed for data on intervention improvements to the overall trial. **Results.** Themes from participants included educational outcomes, motivational outcomes, and use of a self-monitoring tool provided. Participants felt that the workshop provided highly useful information and dispelled many myths. The periodic testing that was performed during the RCT was used by participants as motivation for behaviour change. Views on a self-monitoring device were mixed. The workshop leaders also highlighted the educational benefits but questioned some minor elements concerning some educational tasks and resources used. Feeding back individual ActivPal data was seen very positively, but views on the self-monitoring tool were mixed. **Conclusion.** The structured education workshops were viewed favourably by both leaders and participants. Better self-monitoring of sedentary behaviour is required for greater likelihood of behaviour change.

### **IDENTIFYING THE HEALTH PROMOTION NEEDS OF WHITE COLLARS TO SUPPORT BY INFORMATION AND COMMUNICATION TECHNOLOGIES**

Kuru, H., Ince, M.L.

*Middle East Technical University*

**Introduction** The aim of this study was to identify the exercise stages of change (Contemplation, Preparation, Action & Maintenance) based health promotion coaching needs of white collars (college graduated employees) to provide online coaching support by information and communication technologies (ICT- communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, as well as the various services and applications associated with them, such as mobile applications). **Methods** Participants were 40 college graduate employees (20 women & 20 men) working on a full time job at least five days a week. Mean age of participants was 30.1 years (SD = 3.3). Participants' exercise stages of change was identified by using Physical Activity Stages of Change Questionnaire (Marcus & Lewis, 2003). Moreover, an interview was conducted with each of them. During the interview, participants firstly ranked six cards (persona cards) that were depicting one of the six health promoting behaviors including Health Responsibility, Exercise, Nutrition, Social, Life Appreciation and Stress Management Support by their perceived needs from most to least important. Then, participants were asked three questions; 1) rationale behind their rankings, 2) examples of problems that they faced about each support dimension, and 3) ICT-based solutions for each problem. Quantitative data was analyzed by descriptive statistics and Kruskal-Wallis test ( $p < .05$ ). Interview data was analyzed by content analysis method. **Results** Findings indicated that ICT supported health promotion coaching needs of college graduated employees differed in terms of exercise stages of change ( $p < .05$ ). Kruskal-Wallis test results were significant for Stress Management Support,  $H(3) = 7.82, p < .05$ . According to pairwise multiple comparisons, Preparation stage participants' perceived needs on Stress Management Support were significantly higher than Contemplation stage participants' perceived needs. In addition, persona card rankings' differed in each stage. Contemplation stage participants ranked Health Responsibility Support; Preparation and Maintenance stage participants ranked Nutrition Behavior Support; and Action stage participants ranked Exercise Support as their most important health promotion coaching needs. Furthermore, interview findings supported the ranking differences by exercise stages of the participants. **Discussion** ICT supported health promotion coaching needs of college graduate employees differed by their exercise stages of change. Current study provides evidence about the college graduate employees expectations from ICT supported health promotion coaching systems in terms of exercise stages of change. Future ICT based health promotion coaching systems should consider the college graduate employees' exercise stages of change to meet the specific perceived needs of this group. **References** Marcus, B. H., & Lewis, B. A. (2003). Physical Activity and the Stages of Motivational Readiness for Change Model Contact hkuru@metu.edu.tr

## **Oral presentations**

### **OP-SH06 Psychology (Self-determination)**

#### **EXAMINING PATTERNS OF CHANGE IN SELF-DETERMINED EXERCISE MOTIVATION USING LATENT GROWTH CURVE MODELS.**

Weman-Josefsson, A.K., Lindwall, M., Ivarsson, A.

*Halmstad University*

Few previous studies have targeted how self-determined motivation changes within persons across shorter periods of time (e.g., weeks). Latent growth curve models allow study of within-person change and between-person differences in within-person change over time. The purpose of the study was to study within-person change and between-person differences in change in exercise and motivation in a sample of 2797 exercisers in a natural course of events (i.e. no intervention) over a period of eight weeks. Motivational variables related to self-determination theory were measured by the Basic Psychological Needs in Exercise Scale (BPNES) and the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2) and Godin Leisure-Time Exercise Questionnaire (GLTEQ) was used to assess self-reported exercise level and intensity. The data was analyzed by latent growth curve models in Mplus. The results show significant increase in the average change (mean slope) of psychological need satisfaction whereas there was significant decrease in amotivation. Furthermore, the slopes of variance were significant for all variables except for autonomy, competence and intrinsic motivation, indicating a pattern of heterogeneity in terms of within-person change. No significant changes were detected in exercise level or intensity (METS). The results will be used as reference data in a future intervention study aiming to enhance self-determined exercise motivation in a comparable population.

## EFFECTS OF A SELF-DETERMINATION THEORY-BASED INTERVENTION AT THE ORGANIZATIONAL LEVEL IN SWEDISH SPORT CLUBS

Stenling, A., Tafvelin, S.

*Umeå University*

Introduction Self-determination theory (SDT) provides a useful framework for understanding and explaining motivational processes in sport and exercise settings. It is proposed within SDT that when the social environment support peoples' basic needs of autonomy, competence, and relatedness they become autonomously motivated, increase their well-being, and perform better (Deci & Ryan, 2012). Intervention studies using SDT as theoretical framework have successfully been conducted in exercise, health, and school settings (Su & Reeve, 2011). Few studies, however, have used SDT to understand these motivational processes at the organizational level in sport clubs. Therefore, the purpose of the present study was to examine effects of an intervention aimed at increasing need support from the organizational level in Swedish sport clubs. Method Leaders (N = 152) at the organizational level in 38 Swedish sport clubs participated in a one-week education programme that focused on how these sport clubs could incorporate need supportive strategies for human resource management, goal-setting, and organization. Participants responded to questionnaires about perceived autonomy support from the club, basic need satisfaction, and readiness for change before and after the one-week education programme. The participants also responded to questions about their understanding of the content in the education programme and the perceived usefulness of the content. Results Data have been collected and we will present results from the pre- and post-measures of the short-term learning effects (1 week) and various predictors of these short-term effects, such as perceived autonomy support from the club, basic need satisfaction, and readiness for change. Data will be analyzed with longitudinal multilevel modeling to separate effects at the between- and within-person level. Discussion From a theoretical perspective this study can highlight the usefulness of integrating SDT with the transfer of training literature (cf. Blume, Ford, Baldwin, & Huang, 2010). The results can also show the utility of SDT-based organizational-level interventions in sport clubs. References Blume, B. D., Ford, J. K., Baldwin, T. T., & Huang, J. L. (2010). Transfer of training: A meta-analytic review. *Journal of Management*, 36, 1065-1105. Deci, E. L., & Ryan, R. M. (2012). Motivation, personality, and development within embedded social contexts: An overview of self-determination theory. In R. M., Ryan (Ed.), *The Oxford handbook of human motivation* (pp. 85-110). New York, NY: Oxford University Press. Su, Y-L., & Reeve, J. (2011). A meta-analysis of the effectiveness of intervention programs designed to support autonomy. *Educational Psychology Review*, 23, 159-188. Contact Email: [Andreas.stenling@umu.se](mailto:Andreas.stenling@umu.se)

## SELF-DETERMINATION IN EXERCISE INTERVENTIONS: IMPACT ON FITNESS AND BODY COMPOSITION

Thøgersen-Ntoumani, C.1, Shepherd, S.O.2, Wagenmakers, A.J.M.2, Shaw, C.S.3

*1: Curtin University (Perth, Australia), 2: Liverpool JM University (Liverpool, UK), 3: Deakin University (Melbourne, Australia)*

Objective: To examine the motivational process through which increases in aerobic capacity and decreases in total body fat and abdominal fat are achieved during High Intensity Intermittent Training (HIT) and Moderate Intensity Continuous Training (MICT) interventions. Methods: Eighty-seven physically inactive adults (65% female; age= 42 ± 12, BMI = 27.67 ± 4.99 kg/m<sup>2</sup>) took part in a 10-week randomized intervention testing group-based HIT (repeated sprints of 15-60 s interspersed with periods of recovery cycling ≤ 25 mins/session, 3 sessions.wk<sup>-1</sup>) or Moderate Intensity Continuous Training (MICT; cycling at constant workload of ~65% VO<sub>2</sub>max, 30-45 min.session<sup>-1</sup>, 5 sessions.wk<sup>-1</sup>). Assessments of aerobic capacity (VO<sub>2</sub>max), total body fat and abdominal fat were made pre- and post-intervention. Self-determined motivation was assessed mid-intervention and class attendance was monitored throughout. Analyses controlled for treatment arm and baseline values, and path analysis (using EQS 6.2) was employed. Results: Above and beyond baseline levels of VO<sub>2</sub>max, total body fat and abdominal fat, as well as treatment arm, intrinsic motivation during the intervention and overall adherence predicted higher levels of VO<sub>2</sub>max and lower levels of total and abdominal fat at the end of the study. Conclusions: Participants in both HIT and MICT interventions may experience greater gains in fitness and body composition if intrinsic motivation can be fostered during the intervention.

## POTENTIAL UTILITY OF MESSAGE-FRAMING IN ENHANCING SPORT PERFORMANCE

Chew, W.C.E., Kee, Y.H.

*Nanyang Technological University*

Introduction In competitive sports, it is common to see coaches give short and motivational instructions to help athletes enhance performance. One key issue is whether such well-intended pre-game or in-game message is more detrimental than helpful to the athlete given the situation that the athlete is facing. To better understand the consequence of pep-talk messages prior to critical situations in sports, we aimed to test the applicability of the regulatory fit theory through an experimental study involving the manipulation of game situation and coaching message in predicting speed and accuracy of performance. Method Using a computer-simulated game of table tennis, we experimentally manipulated the game such that the participant will be momentarily induced with a prevention- or promotion-focus as they reached a critical game situation. A vigilant- or eager-framed coaching message was then presented depending on the experimental condition that the participant was randomly assigned to. A match between the coaching message (e.g., vigilant) and the induced regulatory-focus (e.g., prevention focus) creates a condition of fit (e.g., prevention fit). The 2 situation (prevention-focus or promotion-focus) x 2 message (vigilant-framed or eager-framed) experimental design allowed us to test the effects of regulatory fit or non-fit (situation x message interaction) on performance. Participants' performances were assessed by time taken to, and accuracy in, clicking on the ball with the mouse pointer. Factorial ANOVA were conducted to test the hypotheses. Result There was significant interaction effect between situation and message on accuracy,  $F(1, 156) = 6.138, p = .014, \text{partial } \eta^2 = .038$ , and a non-significant interaction for time,  $F(1, 156) = .035, p = .851$ . Simple effects analysis to investigate the nature of the interaction effect for accuracy showed that there was no significant difference in accuracy between vigilant ( $M = 3.119$ ) and eager ( $M = 2.969$ ) messages when these messages were presented at promotion-focus situation,  $p = .539$ , but there was a very significant difference ( $p = .004$ ) when they (vigilant,  $M = 2.656$ ; eager,  $M = 3.359$ ) were presented at prevention-focus situation. Discussion In accordance with the regulatory fit theory (Higgins, 2000) and as expected, both prevention- and promotion-fit conditions were linked to higher accuracy compared to their corresponding non-fit conditions, albeit that the difference in accuracy between fit and non-fit was non-significant in the promotion condition. The findings suggest the utility of appropriately framed messages in enhancing performance. The use of vigilant-framed (non-loss) message seems to have a salutary effect on accuracy in performance. References Higgins, E. T. (2000). Making good decision: Value from fit. *American Psychologist*, 5, 1217-1230. Contact Email: [eugene.chew@nie.edu.sg](mailto:eugene.chew@nie.edu.sg)

## Oral presentations

### OP-SH22 Sociology (Sport Science in ECSS)

#### SPORT SCIENCE IN EUROPE: AN OVERVIEW OF ITS CURRENT SITUATION AND ITS EVOLUTION SINCE TWENTY YEARS

Camy, J.

*University of Claude Bernard Lyon*

The purpose is to present the first results of a research project run by a group of European researchers on "Sport Science in Europe". This presentation is mostly based on the treatment of the information contained in the ECSS meta-database (European Database of Sport Science (EDSS) powered by Sportools GmbH.) gathering key information on the 23000 abstracts presented during the 19 ECSS Congresses. The theoretical framework, inspired by the "sociology of scientific knowledge" and the "science studies", considers that scientific activities are run within specific social, cultural, political and economic contexts which influence them. We will present our results following three main categories of questions: 1) What is the "structure of the field of sport science"? Which topics are there and what is their relative importance? The structure of the field of sport science as it is produced within ECSS, reflects the internal debates on its identity and the way they are related to the position of sport science in the entire academic field. The main "tensions" are between a position as close as possible from well established scientific disciplines (basic and sport applied) and a position oriented towards specific professionally led knowledge with some other subcategories of positions. 2) What are the institutions in Europe playing a key role in the sport science production process? The landscape we have just described is mostly supported by sport science research and education institutions, themselves part of an academic environment in different European countries. We will examine which are the key actors in the field of sport science and in which way they contribute to the internal debates presented above. 3) How do sport scientists work in that production process? The key producers of sport science remain sport scientists. Taking care of the limitations of our sources of information, we will examine how they construct their scientific environment. In particular we will see with which other scientists they collaborate at local, national and international level and into which formal and informal networks they operate. We will see also which relations they have with other sport and physical activities stake holders. References: (1) Balague Serre, N., Torrents Martin C., "Unifying Sport Science", *Apunts*, N°114, 2013 (2) Bloor, David; Barnes, Barry & Henry, John, *Scientific knowledge: a sociological analysis*, Chicago: University Press, 1996. (3) Camy, J. The emergence of a « European Higher Education Area » and its corollary in "Sport Sciences": consequences on the status of formal education in Societies, «autonomy» or « embedment »? in Tokarski W. (Ed) *Festschrift*, Hofmann Publisher. (4) Renson, R.: *History of sport science: hanging together or hanging separately?* Presentation to the ECSS Congress, Copenhagen, 2001. (5) Vinck, D., *The Sociology of Scientific Work. The Fundamental Relationship between Science and Society*. Cheltenham, Edward Elgar, Prime Series on Research and Innovation Policy in Europe, 2010.

#### THE ACADEMISATION OF SPORT IN SWEDEN

Wirén Aakesson, J.

*Institution of Sport Sciences*

Introduction In recent years, sport has undergone a remarkable academisation process in Sweden. Since the 1970s a broad field of sport research has been established within which scientific knowledge is being produced. A series of higher educations in the area has formed since the new millennia - through which scientific knowledge is mediated to students. In addition, the demand for labor in the sports labor market has increased in recent decades – and the demand for academic background is not unusual. This study deals with the sport academisation process. The purpose is to extend knowledge and understanding of higher sport science education and its relationship to sport research, and the sport labor market. The research questions are: What knowledge is produced within sport research, what knowledge is mediated through higher sport education, and what knowledge is demanded in the sport labor market? How does the production, mediation and demand for scientific knowledge relate to each other? Do they differ and if so in what ways and why? The study has two main theoretical perspectives. The first is Academisation (Dellgran & Hojer 2000) – which concerns how a field of general knowledge develops into a field of scientific knowledge. The second is Institutionalization – which is used to study how sport as an academic area has become structured in Sweden (Powell & DiMaggio 1991). Methods The empirical material mainly consists of various documents, such as: dissertations, journal articles, educational curriculums, job listings, and various statistical materials. The documents have been analyzed quantitatively as well as qualitatively, through content analysis. Results The study shows that there are discrepancies between produced, mediated and demanded knowledge. The largest proportion of research has been produced within fields that are closely connected to PE-teacher educations. At the same time, almost half of the educations are within Sport Management – an area where there is very little research being conducted in Sweden. Although there is a large demand for labor in the sport labor market, the employment opportunities mainly consist of temporary part-time employments. The demand for scientific knowledge also varies between different professional roles. For some professions, an academic background is essential, for others it has less importance. Discussion Sport research, higher sport education and the sport labor market has its own distinct histories and institutions, and therefor reproduces different ideas, ideals and logics. The three arenas are partly separate and have their own distinct characteristics, but are also interwoven in specific ways. References Dellgran, Peter & Hojer, Staffan (2000). *Knowledge-formation, Academisation and Professionalization in social work* (transl.). Diss. Gothenburg: Univ. Powell, Walter W. & DiMaggio, Paul J. (ed.) (1991). *The new institutionalism in organizational analysis*. Chicago: University of Chicago Press

#### CONTENT LEXICAL ANALYSIS ON INTERDISCIPLINARITY IN SPORT SCIENCES

Fargier, P., Massarelli, R.

*Université de Lyon, Université Claude Bernard Lyon 1, Centre de Recherche et d'Innovation sur le Sport (CRIS, EA 647), 69622 Villeurbanne cedex, France*

Interdisciplinary research in Sport Sciences is a challenge, a fortiori when one aspires to more than basic multidisciplinary (i.e. the distinct studies of a given objet by several scientific disciplines). While calling to the coverage of societal questions (e.g. health status of the populations) several sponsors invite researchers to go beyond such perspectives. Moreover, some researchers from different domains tend to collaborate with the aim to develop a unitary approach of a given object (e.g. collaborations between psychologists and neuroscientists in the study of motor control). Some attempts to produce more transversal conceptual frameworks may also be noticed (e.g. the courses

of action approach). From such standpoint the present study examined the conceptions of interdisciplinarity among European senior researchers in Sport sciences. The interviews of a sample of such researchers chosen for their affinity with interdisciplinarity (50% of them specialized in Social sciences and humanities and 50% specialized in Life sciences) have been analyzed with the support of Alceste plus© software. The results of the lexical analysis allowed a categorical analysis resulting in the determination of the reference worlds of the speeches, thus to the sense of the lexical categories. A preliminary study (8 interviews, 28 775 forms, 874 lexems and 702 elementary unities of context) led to hierarchical descendent classifications allowing the determination of 7 lexical categories. The subsequent categorical analysis led to the determination of 3 reference worlds underlining: 1) the development of methods applicable to several objects of study and scientific areas; 2) the appeal to methods of a specific domain to direct and/or validate the analysis of data gathered via methods and tools of another scientific domain; 3) a reflection on the institutional and managerial conditions favorable to interdisciplinary research (notably relative to the academic world and to the industry) and on the direction of the corresponding research projects (to reduce the gaps between the ecology of a social domain of activity and the scientific reductionism and/or the study of an epiphenomenon vs. the study of a corresponding underlying process). A content analysis of EDSS abstracts relative to PE (produced from 1996 to 2014) will be shortly realized as a complement to the interviews with the purpose to produce the state of the art on interdisciplinarity and of its possible variations compared with the reflection on interdisciplinarity in Sport sciences among senior researchers.

### THE FANS CAN: A SWEDISH CASE STUDY

Radmann, A., Hedenborg, S.

*Malmö University*

Background: The technological development of media has changed ways of communication among fans. Fans can present themselves and their activities in a perspective they chose instead of relying on official club information or newspapers not seldom presenting fans as a problem rather than as a resource. In that way the new mediated experience allows for a broader audience to move from mere spectator to participant (cultural citizenship), and for the empowerment of fans. These experiences can be used to question who is the righteous member of a football club or carrier of the football culture. The project will map out and analyse these activities. In addition, the notion of new media technologies as enabling fans will be critically examined. It is possible that despite the growing membership action on the internet sites, the real power of the football clubs is still in the hands of the club board and the owners. Furthermore, not all groups (in relation to gender and social class for example) have equal access to new media technologies. Furthermore the question of how the football club should be organized is of importance. Not the least, the question of the influence of commercialization on a membership organization or the democratic process. This is, however, not isolated to fandom cultures. It is an important question for societal change over-all as a pivotal question is: who is to decide to what extent market forces are to influence the society? A gender perspective will be used.

**18:00 - 19:30**

## Oral presentations

### OP-PM64 Nutrition: Amino acids and proteins

#### TWENTY-FOUR WEEKS OF $\beta$ -ALANINE SUPPLEMENTATION DOES NOT AFFECT CLINICAL MARKERS OF HEALTH: PRELIMINARY FINDINGS

Saunders, B.1, Painelli, V.S.1, Silva, V.E.1, Silva, R.1, Sale, C.2, Harris, R.C.3, Artioli, G.G.1, Gualano, B.1

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Introduction:  $\beta$ -alanine is a popular ergogenic aid used by athletes worldwide; 61% of around 600 Australian team sports players reported taking the supplement (Kelly et al., 2013). There is currently no evidence on the safety of long-term supplementation and its effects on health parameters. Aim: To investigate the effects of chronic  $\beta$ -alanine supplementation on markers of health. Methods: Sixteen healthy male participants (age  $27 \pm 4$  y; height  $1.73 \pm 0.10$  m; body mass  $78.9 \pm 11.7$  kg) were supplemented with 6.4 g/day of sustained release  $\beta$ -alanine (N=11; CarnoSynTM, NAI, USA) or placebo (N=5; maltodextrin, NAI, USA) over a 24-week period. Resting venous blood samples were taken in the supine position every 4 weeks and analysed for markers of renal, hepatic and muscle function (aspartate transaminase; alanine aminotransferase; alkaline phosphatase; lactate dehydrogenase; albumin; globulin; creatinine; estimated glomerular filtration rate and creatine kinase). Data were analysed using mixed model ANOVA. Results: The present results are from a larger investigation that is currently ongoing. There were no self-reported side effects in these participants throughout the study. There was no effect of treatment, time or any interaction effects on any blood marker (all  $P > 0.05$ ) except alkaline phosphatase, which had a significant interaction effect ( $P = 0.006$ ). Post-hoc analysis revealed a difference only within the placebo group between weeks 4 and 12. Importantly, mean and individual analysis of data revealed blood parameters remained within normal range and did not significantly change across time with  $\beta$ -alanine supplementation. Conclusions: Twenty-four weeks of  $\beta$ -alanine supplementation at 6.4 g/day did not adversely affect clinical markers of renal, hepatic or muscle function in these healthy participants. These results have important implications for athletes who are likely to supplement with  $\beta$ -alanine for extended periods of time. Future analysis of muscle taurine will further contribute to the safety profile of long-term  $\beta$ -alanine supplementation. References: Kelly, V. G., Jenkins, D. G., Leveritt, M. D., Brennan, C. T., & Slater, G. J. (2013). Evaluation of the prevalence, knowledge and attitudes relating to  $\beta$ -alanine use among athletes. *British journal of sports medicine*, 47(17), e4-e4. Contact: drbryansaunders@outlook.com Bryan Saunders and Vitor de Salles Painelli have been financially supported by Fundação de Amparo à Pesquisa do Estado de Sao Paulo (FAPESP grants number: 2011/19513-2 and 2013/04806-0).

### AMELIORATING EFFECT OF BRANCHED-CHAIN AMINO ACIDS SUPPLEMENTATION ON MARATHON-INDUCED MUSCLE DAMAGE, INFLAMMATION AND MUSCLE SORENESS

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**Introduction** Several laboratory studies reported that Branched-Chain Amino Acids (BCAA) attenuated eccentric exercise induced delayed-onset-muscle-soreness (DOMS) and muscle damage (Shimomura et al., 2010). Immediate-onset muscle soreness (IOMS) is frequently observed in exercise involving running, particularly in long distance running, such as the marathon event, with onset sometimes even occurring during exercise. Although, in our preliminary study, BCAA ingestion improved systemic fatigue and IOMS after a full-marathon (Ishikura et al., 2014), its effectiveness on muscle damage and inflammation induced by long distance running is unknown. This study investigated, in a randomized, placebo-controlled, and double-blind manner supplemented, the inhibitive effect of BCAA ingestion on marathon-induced muscle damage and inflammation in non-professional full-marathon runner. **Methods** Subjects were 36 non-professional runners participating in a full-marathon race. They received either 3.2g of BCAA or placebo 3 times a day, from the day before to three days after the event. Serum creatine kinase (CK), aldolase, glutamic-oxalocetic transaminase (GOT), lactate dehydrogenase (LDH), C-reactive protein (CRP) were measured as well as systemic fatigue and muscle soreness, before, immediately after, and 1 to 4 days after the event. Systemic fatigue and soreness in seven muscle regions were evaluated using a numeric rating scale. **Results** Since the increase in score peaked at immediately after the marathon, IOMS was observed in all examined muscle regions. Measured biochemical markers peaked at 1 day after the event. BCAA ingestion was observed to significantly decrease IOMS in the anterior thigh and buttock areas. In addition, BCAA ingestion significantly inhibited the serum CK, GOT, and CRP concentrations induced by the marathon. **Discussion** This study revealed that the effectiveness of BCAA ingestion on reducing muscle damage, inflammation, and IOMS after the running of a full marathon as well as eccentric exercise induced muscle damage and DOMS. On the basis of this result, it is proposed that BCAA supplements can be administered to ameliorate muscle damage, inflammation, and muscle soreness induced by various types of exercise. **References** Shimomura Y, Inaguma A, Watanabe S, Yamamoto Y, Muramatsu Y, Bajotto G, Sato J, Shimomura N, Kobayashi H, and Mawatari K. (2010). *International Journal of Sport Nutrition and Exercise Metabolism*, 20, 236-44. Ishikura K, Miyazaki T, Ra SG, Ohmori H. (2014). *Advances in Exercise and Sports Physiology*, 20(1) 9-17 Contact E-mail address: ishikura.keisuke.fw@tsukuba.ac.jp

### METABOLIC CONSEQUENCES OF B-ALANINE SUPPLEMENTATION DURING SUPRAMAXIMAL CYCLING AND 4000-M TIME TRIAL PERFORMANCE IN HIGHLY-TRAINED CYCLISTS

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**INTRODUCTION:**  $\beta$ -alanine supplementation may enhance short-duration, high-intensity exercise performance. Nonetheless, several questions remain unanswered regarding the effects of  $\beta$ -alanine supplementation on energy provision, acidosis, and metabolite accumulation. The present study examined changes in the contribution of the aerobic and anaerobic energy systems during a 4000-m cycling TT, as well as the resultant acidosis and metabolite accumulation during supramaximal cycling before and after  $\beta$ -alanine supplementation. **METHODS:** Sixteen highly-trained cyclists ( $n = 2$  women;  $\text{VO}_2\text{max} = 66.6 \pm 10.4 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ) were administered 6.4 g of  $\beta$ -alanine or placebo daily for 4 wk. Subjects performed a supramaximal cycling bout to exhaustion (equivalent to 120%  $\text{VO}_2\text{max}$  determined at 0 wk) before (Exh0wk) and immediately after (Exh4wk) the 4-wk supplementation period as well as an additional test identical in duration and power output to Exh0wk (Match4wk). Anaerobic capacity and blood pH, lactate and bicarbonate concentrations were measured pre-, immediately post-, and 5 min post-exercise. Subjects also performed a 4000-m cycling TT before and after supplementation with anaerobic and aerobic attributable power output estimated from the gross efficiency method (Serresse, 1988; Noordhoff, 2011). Absolute changes in performance and physiological variables were compared using a two-way ANOVA and magnitude-based inferences were calculated for each variable (Hopkins, 2007). **RESULTS:**  $\beta$ -alanine supplementation elicited significant increases in time to exhaustion ( $18.4 \pm 1.5$  s;  $p = 0.029$ ) and anaerobic capacity ( $2.0 \pm 1.2 \text{ mL} \cdot \text{kg}^{-1}$ ;  $p = 0.0043$ ) in Exh4wk compared to Exh0wk. Furthermore,  $\beta$ -alanine supplementation resulted in a possibly beneficial attenuation in the decrease in blood pH immediately post-exercise ( $0.039 \pm 0.056$  units; 48% likelihood;  $p = 0.087$ ) and 5 minutes post-exercise ( $0.032 \pm 0.047$  units; 33% likelihood;  $p = 0.098$ ) in Match4wk compared to Exh0wk. Performance time in the 4000-m TT was likely to be beneficial following  $\beta$ -alanine supplementation ( $-7.9 \pm 10.1$  s; 93% likelihood;  $p = 0.063$ ) and the mean anaerobic power output was possibly likely to be greater ( $14.2 \pm 23.8$  W; 70% likelihood;  $p = 0.134$ ). **DISCUSSION:** These results suggest that  $\beta$ -alanine supplementation is beneficial to cycling performance in highly trained cyclists, presumably by elevating carnosine content, and providing a practically meaningful attenuation in the reduction in blood pH. Furthermore,  $\beta$ -alanine supplementation increased anaerobic capacity which was also reflected by a meaningful increase in the anaerobic attributable power output during a 4000-m cycling TT, resulting in an enhanced overall performance. **REFERENCES:** Serresse O, Lortie G, Bouchard C, Boulay M. (1988). *Int J Sports Med*, 9, 456-460. Noordhoff D, Vink A, de Koning JJ, Foster C (2011). *Int J Sports Med*, 32(6):422-428. Hopkins W, Marshall S, Batterham A, Hanin J (2009). *Med Sci Sports Exerc*, 41(1), 3-12. **CONTACT:** p.bellinger@griffith.edu.au

### DIETARY PROTEIN INTAKE AND DISTRIBUTION OF ELITE AUSTRALIAN TEAM-BASED SPORT ATHLETES

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**Introduction** The physical demands placed on elite athletes require optimal dietary intake to maximise performance, facilitate adaptations, assist in recovery and prevent illness and injury. Dietary protein ingestion, in particular, plays an important role in muscle synthesis and recovery. Both the consumption of high quality protein immediately following exercise, and the exercise bout itself can stimulate the muscle protein synthetic response, for up to 24 hours. Therefore, current sport nutrition guidelines highlight the importance of timing and distribution of total dietary protein intake to optimise adaptations. Yet, there is minimal research reporting dietary protein intake patterns of elite male team-based sport athletes. **Objective** To explore and gain insight into the current dietary intake practices, specifically protein distribution, of elite male team-based sport athletes. **Methods** Thirty nine elite male Australian football (AF) athletes ( $23.1 \pm 2.6$  yrs,  $88.1 \pm 8.2$  kg) and twenty five elite male soccer athletes ( $25.3 \pm 5.4$  yrs,  $75.6 \pm 6.5$  kg) participated in the study. Dietary intake data was obtained via 3-day food records and 24-hour dietary recalls during the 2013 and 2014 pre-season periods for AF and soccer respectively. Average reported total daily energy and macronutrient intake, as well as meal and snack intake was analysed. Meals and snacks were defined according to timing of intake over a 24 hour period. Subgroups based on years at elite level and self-reported weight goals were created for analysis. **Results** Average total reported energy and protein intake was  $13.6 \pm 3.1$  MJ,  $196.0 \pm 57.0$  g

( $2.2 \pm 0.6$ g/kg) and  $9.4 \pm 2.3$ MJ,  $140.4 \pm 35.1$ g( $1.9 \pm 0.5$ g/kg) for AF and soccer athletes respectively. Soccer and AF athletes reported 4.5 eating occasions (3 meals, 1.5 snacks) and 5.1 eating occasions (3 meals, 2.1 snacks) per day, respectively. Protein intake was skewed towards the evening meal for all athletes. The majority of protein was consumed at main meals (86% and 89% of total protein, Breakfast:  $35.8 \pm 22.3$ g,  $18.3 \pm 8.9$ g; Lunch:  $56.9 \pm 25.5$ g,  $48.2 \pm 20.9$ g; Dinner:  $76.2 \pm 23.5$ g,  $58.0 \pm 29.0$ g; AF and soccer athletes respectively). Snacks contributed little to total protein intake but AF athletes consumed significantly more protein at the evening snack ( $10.3 \pm 13.6$ g,  $1.4 \pm 2.7$ g;  $p < 0.05$ ). Discussion This is the first study reporting protein intake patterns of elite Australian male team-based sport athletes. There is ongoing debate in the literature regarding ideal protein intake recommendations for athletes, despite a lack of research reporting the current dietary intake practices. Elite athletes appear to be meeting total protein intake recommendations however could further increase training adaptations and potentially improve performance if distribution of protein intake was optimised. Contact b.devlin@latrobe.edu.au

### EFFECT OF WHEY PROTEIN HYDROLYSATE ON ADAPTATION TO ENDURANCE TRAINING IN WELL-TRAINED RUNNERS

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INTRODUCTION: Long distance endurance athletes wish to enhance fat oxidative capacity to delay the emptying of the glycogen stores. Training with low carbohydrate availability seems to enhance enzymatic adaptations, whereas the influence of a timed protein intake on adaptation to endurance training is not clarified. PURPOSE: To study the effect of intake of whey protein hydrolysate (WB) before and after each exercise session compared to isocaloric control on mitochondrial adaptation to six weeks endurance training in well-trained runners. METHODS: 24 well-trained endurance runners (Age  $30 \pm 9$  yrs,  $VO_{2max}$   $61 \pm 4$  ml  $O_2$  min<sup>-1</sup> kg<sup>-1</sup>) participated in a block randomized controlled intervention trial including a six weeks running program. Half of the runners ingested WB before ( $0.3$  g kg<sup>-1</sup>) and WB+carbohydrate ( $0.3$  g protein kg<sup>-1</sup> +  $1$  g carbohydrate kg<sup>-1</sup>) after each exercise session (PRO). The others ingested isocaloric carbohydrate before and after exercise (CAR). Muscle biopsies were obtained before and after the first training session. Before and two days after the intervention period post-absorptive muscle biopsies were obtained and  $VO_{2max}$  and 6k performance were tested. Daily protein intake excluding intervention beverages was not different between groups. RESULTS: Western blot analysis showed group difference in adaptations in Cyt C (PRO  $19 \pm 8\%$ , CAR  $-17 \pm 13\%$ ,  $p < 0.05$ ). Tendencies towards similar adaption pattern were observed for other mitochondrial targets (VDAC, HSP60, PHB1, SDHA; intervention interaction  $p < 0.1$ ). mRNA expression of mitochondrial PGC1- $\alpha$  was acutely enhanced after the first running session (0hr post-exercise  $339 \pm 27\%$  and 2 hr post-exercise  $651 \pm 25\%$ ,  $p < 0.01$ ), but not influenced by intervention beverages. Improvements were observed in 6k-run performance test ( $25 \pm 1$  sec,  $p < 0.01$ ) and  $VO_{2max}$  ( $0.07 \pm 0.01$  L  $O_2$ /min,  $p < 0.05$ ) compared to baseline, but no intervention interaction was observed CONCLUSION: Intake of whey protein seems to have a positive influence on mitochondrial adaptations in well-trained runners and might be beneficial for performance in a longer time perspective.

## Oral presentations

### OP-PM30 Sports Medicine & Orthopedics: Physiotherapy I

#### EFFECTIVENESS OF EXERCISE THERAPY IN TREATMENT OF PATELLOFEMORAL PAIN SYNDROME: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Introduction This systematic review and meta-analysis was accomplished to determine whether exercise therapy is an effective intervention to reduce pain and patient reported measures of activity limitations and participation restrictions (PRMALP) in patients with patellofemoral pain. Methods Randomized controlled trials in English and German language, published in Medline, PEDro and Cochrane databases were searched. Eligibility was assessed in two stages. The methodological quality of the studies was rated using the PEDro scale. Data were pooled using random-effects meta-analysis allowing for variability among studies. For clinical use, overall estimates were re-expressed in the original VAS scores. Significance was set at 5%. Results Fifteen studies with a total of 748 participants were included and pooled for a meta-analysis. Six studies compared the effect of exercise therapy with a control group neither receiving exercise therapy nor another intervention. Four studies compared the effect of exercise therapy versus additive therapy while five papers compared different exercise interventions. In both comparisons exercise therapy resulted in strong pain reduction and improvement of PRMALP effects. Significant short-term effects ( $\leq 12$  weeks) of exercise therapy were found for pain and PRMALP while long-term effects ( $\geq 26$  weeks) were observed for PRMALP only. Conclusion This meta-analysis presents evidence that exercise therapy has a strong pain reducing effect and decreases PRMALP in patients with patellofemoral pain. However, the question, which exercise modality yields the strongest reducing effect on pain and PRMALP, remains unrevealed. The 15 studies included in this analysis were of variable quality. Large, high quality RCTs are needed to further the evaluation of the possible effects of different exercise therapy modalities on patellofemoral pain. References Clijisen R, Fuchs J, Taeymans J. (2014), Phys Ther, Dec;94(12):1697-708. doi: 10.2522/ptj.20130310. Epub 2014 Jul 31. Contact ron.clijisen@supsi.ch

#### EFFECTS OF BRANCHED-CHAIN AMINO ACIDS SUPPLEMENTATION ON CHANGES IN KNEE EXTENSOR MUSCLES FUNCTION AND ENERGETIC METABOLISM RESULTING FROM EXERCISE-INDUCED MUSCLE DAMAGE

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Introduction Branched-chain amino acids (BCAAs) promote muscle-protein synthesis, reduce protein oxidation (Wang and Proud, 2006) and have positive effects on mitochondrial biogenesis and reactive oxygen species scavenging (D'Antona et al., 2010). The purpose of the study was to determine whether these might be translated at the level of changes in force capacity (MVC), muscle soreness (DOMS) and



muscle energetics resulting from severe muscle damage (Fouré et al., 2015). Methods Young healthy men were randomly assigned to a group supplemented with BCAAs (n=13) - leucine, isoleucine and valine (2:1:1, 100 mg/kg) - or placebo (n=13). Supplementations were taken by each subject: three times the day of the damaging exercise and once daily on the four recovery days after exercise-induced muscle damage (EIMD). The damaging exercise consisted of 40 isometric electrically evoked knee extensions (100 Hz, duty cycle: 12.5%) with joint angle fixed at 100° (0° = full extension). MVC and DOMS of the knee extensors were assessed before, two (D2) and four (D4) days after EIMD. Metabolic variables including concentrations of phosphocreatine (PCr), inorganic phosphate (Pi) and pH were measured during a standardized rest-exercise-recovery protocol using <sup>31</sup>P spectroscopy before, and D2 and D4. Results EIMD led to both a similar decrease in MVC (-24% at D2 and -21% at D4) and increase in DOMS in the two groups. In addition, we found a similar increase in resting [Pi] (+42% at D2 and +34% at D4), resting cellular acidosis (-0.04 pH unit at D2 and -0.03 pH unit at D4) and a slower PCr recovery rate (-18% at D2 and -24% at D4). Discussion These results showed no effect of BCAAs supplementation on decreased MVC and increased DOMS whereas with a similar BCAAs intake, previous studies did (e.g., Howatson et al., 2012). The large extent of muscle damage induced in the study might have limited the potential benefits associated to BCAAs supplementation on changes in MVC, muscle soreness and energetic metabolism after EIMD. A 100 mg/kg BCAAs supplementation was unsuitable to attenuate metabolic and functional alterations resulting from severe muscle damage. References D'Antona G., Ragni M., Cardile A. et al. (2010). *Cell Metab.* 12:362-72. Fouré A., Wegrzyk J., Le Fur Y. et al. (2015). *Med Sci Sports Exerc.* In press. Howatson G., Hoad M., Goodall S. et al. (2012). *J Int Soc Sports Nutr.* 9:20. Wang X. and Proud C. (2006). *Physiology* 21:362-9.

### TRAINING AND DE-TRAINING EFFECTS : SIX-MONTH FOLLOW-UP OF A 3-MONTH RESISTANCE EXERCISE PROGRAM IN THE MILD DEMENTED ELDERLY

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Background and Purpose: The fastest growing age segment of population worldwide is the 'elderly' (65 years and older), a high-risk group for developing dementia. Evidence showed resistance training may potentially improve neuronal and thus cognitive functions. Therefore, the main purpose of this study is to investigate the effects of resistance training on cognitive function and muscle strength. Method: Forty mild dementia elderly were randomly assigned to two groups: resistance training (RT, N= 22) and control group (CG, N=18). The inclusion criteria: (1) community-dwelling elderly aged  $\geq 65$ , (2) CDR score: 0.5 or 1 (3) having no functional disabilities that would restrict for exercise participation. The hydraulic resistance exercise (HRE) equipments were used 40 minutes/session, twice weekly for resistance training. CG maintained their regular daily activities. Outcome measures included cognitive ability screening instrument (CASI) and muscle strength (grip strength (GS), knee extension (KE), 30sec chair stand(CS) and 30sec arm curl(ACI)). Independent t-test was used to compare baseline demographic variables. Repeated measure ANOVA was used to compare the group and time effects. Wilcoxon signed rank test by using the mean differences of pre-post-test was analyzed. Result: There were no significant differences of baseline data among 2 groups except for the CASI (t=2.029, p=0.049) and GS (t=3.127, p=0.003). The results showed significant interaction in KE (F=38.000, p=0.017) and ANML in CASI (F=5.821, p=0.021), significant group effect in CASI (F=8.900, p=0.005), KE (F=10.289, p=0.003), GS (F=13.216, p=0.001), CS (F=8.133, p=0.007), STM (F=14.646, p=0.000), ATTN (F=8.497, p=0.006), MENMA (F=4.937, p=0.032) and LANG (F=4.592, p=0.039), significant time effect in GS (F=4.510, p=0.04), CS (F=8.590, p=0.006), and STM (F=10.270, p=0.003). Wilcoxon test revealed significant training effect of KE in RT compared with CG group (z= -2.528, p=0.011). The CASI (z= -2.112, p=0.035) and STM (z= -2.605, p=0.009) of RT showed significantly improve post-training, while, the CS (z= -2.365, p=0.018) in CG decreased significantly after 3 months. Conclusion: Mild dementia elderly people undergo 3-month resistance training showed significant improvements in cognitive function, lower extremity muscle strength and some physical functions, however, only muscle strength reached group difference. Besides, the effects attenuated especially in the control group at 6-month after intervention.

### ECCENTRIC-OVERLOAD RESISTANCE EXERCISE USING FLYWHEEL IMPROVES COGNITIVE FUNCTION AND INCREASES MUSCLE SIZE, POWER AND PERFORMANCE IN STROKE VICTIMS

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Introduction To combat neuromuscular dysfunction following stroke, resistance exercise (RE) including high-force muscle actions, has shown efficacy. Compromised physical abilities consequent to stroke, are typically accompanied by impairment of multiple cognitive functions. Investigations have disclosed positive impacts of RE on different cognitive domains (Cassilhas et al. 2007). Further, eccentric (ECC) muscle actions, critical in evoking skeletal muscle adaptations, induced greater cortical activities and involved more functional regions of the brain, than concentric actions (Fang et al. 2004). The current study explored the effects of 12-week ECC-overload flywheel RE training of the paretic limb of chronic stroke patients, on muscle and cognitive functions. The study design allowed for examining the relationship between adaptations of skeletal muscle and cognitive functions. Methods Thirty-two stroke patients were randomly assigned to a training group (TG) performing ECC-overload flywheel RE (12 weeks; 2 times/week; 4 sets of 7 maximal repetitions; total contractile activity time < 2 min per session) or a control group (CG) that followed their prescribed daily routines. Cognitive function, m. quadriceps femoris (QF) volume and cross sectional area (CSA), and maximal force and power were assessed before and after the training period in both TG and CG. Results TG improved power in the affected, trained (48%; P<0.0005) and the non-affected, untrained leg (28%; P=0.006). QF muscle volume and CSA of the affected leg increased by 9% (P<0.0005). Executive functions (working memory and verbal fluency tasks) and speed of information processing improved in the TG (P<0.04) after the intervention. Significant correlations were found between QF volume and CSA gains on one hand, and verbal fluency improvements (P=0.01-0.014; R=0.49-0.64). There were no changes in CG. Discussion In supporting our recent findings (Fernandez-Gonzalo et al. 2014), the current data suggest flywheel RE using ECC-overload offers an efficient and very powerful tool to improve neuromuscular function and performance, accompanied by marked muscle hypertrophy in chronic stroke patients. The most novel finding of this study however, was the parallel improvement in several cognitive functions. Indeed, correlation analysis inferred there is significant crosstalk between certain brain domains and skeletal muscle. These important adaptations occurred after only 24 exercise sessions, with less than 4 min per week dedicated to muscle contractile activity. References Cassilhas RC, Viana VA, Grassmann V, Santos RT, Santos RF, Tufik S, Mello MT (2007). *Med Sci Sports Exerc* 39 (8):1401-1407. Fang Y, Siemionow V, Sahgal V, Xiong F, Yue GH (2004). *Brain Res* 1023 (2):200-212. Fernandez-Gonzalo R, Nissemark C, Aslund B, Tesch PA, Sojka P (2014). *J Neuroeng Rehabil* 11 (1):150. Contact rodrigo.gonzalo@ki.se

## INCREASED EXERCISE INTENSITY DURING INTERVAL ROBOT-ASSISTED GAIT THERAPY IN SPINAL CORD INJURED PERSONS

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Background: Exercise intensity (in terms of cardiometabolic load) is relatively low during current 30-min continuous Robot Assisted Gait Therapy (RAGT)(1). This may in part limit the effectiveness of RAGT induced gait improvement in individuals with incomplete spinal cord injury (iSCI). Exercise intensity may be increased by applying interval exercise with high intensity exercise bouts. Objective: To determine if high intensity interval RAGT is feasible and to evaluate if muscle activity and cardiometabolic load are higher than during continuous exercise. Subjects: Nine subjects with iSCI (ASIA impairment scale C or D). Methods: All subjects performed a 30-minute interval exercise and a 30-minute continuous exercise in the Lokomat. During both sessions EMG activity of the lower-limb muscles and different cardiorespiratory responses (%HRR, VO<sub>2</sub>, VCO<sub>2</sub>, VE and RER) were obtained. Furthermore, all patients filled out the Borg-scale for rate of perceived exertion (RPE) and a self-developed questionnaire about their experiences with both sessions. Results: All subjects successfully completed the interval exercise on the Lokomat. Both the muscle activity and the cardiorespiratory responses were increased during the interval exercise compared to the continuous exercise, although for the muscle activity this difference was not significant. During the interval exercise, subjects' average %HRR was more than 15% higher than during the continuous exercise (33.6% vs. 18.0%). Besides, during the interval exercise subjects exercised almost half of the time (48%) above levels of aerobic exercise (>30% HRR), while this percentage was only 8% during the continuous exercise. In addition, the RPE was significantly higher after the interval session (mean 12.8 (1.3)) than during the interval session (mean 10.9 (1.7)). Nevertheless, 78% of the subjects preferred the interval session over the continuous session. Conclusion: Persons with iSCI can perform a high intensity interval RAGT. Besides, this study clearly demonstrates that the cardiometabolic load during this interval exercise is higher than during a continuous exercise. In addition, the cardiometabolic load during the interval exercise was high enough to reach levels of aerobic exercise, which may lead to an increased exercise capacity. Future research should clarify whether this type of RAGT exercise is effective in regaining walking ability for persons with iSCI. 1. F. Hoekstra et al. Effect of robotic gait training on cardiorespiratory system in incomplete spinal cord injury, *J. Rehabil Res Dev*, 50(10) pp. 1411-1422, 2013.

## THE IMPACT OF SIMVASTATIN ON INSULIN SENSITIVITY IN PATIENTS WITH AND WITHOUT MYALGIA

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Introduction Simvastatin is a commonly prescribed cholesterol-lowering drug used to reduce the risk of cardiovascular disease. Despite the beneficial effects of simvastatin, adverse effects such as myalgia, muscle cramps, and fatigue have frequently been reported (1). Occurrence of the aforementioned adverse effects may inhibit a physically active lifestyle, which may further maintain or potentially worsen an already unhealthy way of living. The aim of this study is to investigate if insulin sensitivity is affected in subjects with or without simvastatin-associated myalgia. We hypothesize that subjects with myalgia, not without, have impaired insulin sensitivity, as shown in the study from Mallinson et al. (2), where subjects with myalgia had impaired insulin sensitivity compared to healthy non-statin users. Methods We will include 60 subjects with normal glucose tolerance undergoing treatment with simvastatin to participate in three separate trial days. The study is presently ongoing and 16 subjects have been completed. The subjects were divided into two groups based on the presence or absence of self-reported myalgia assessed by VAS-score. DXA-scan was used to measure body composition. Whole body stimulated glucose uptake was assessed by the hyperinsulinemic euglycemic clamp technique. A constant insulin infusion was administered intravenously over 2 hours with a concentration of 80 mU/m<sup>2</sup>/min and IV glucose was given at variable rates to keep the blood sugar at a constant level of 5.6 mM. Maximal whole body stimulated glucose uptake was calculated as the average glucose infusion rate during the last 30 min. Results 9 subjects with myalgia (5 M/4 F; age 61 +/- 2 years; weight 91 +/- 8 kg; BMI 30 +/- 2; fat % 38 +/- 4; FFM 56 +/- 4 kg; VAS 4.6 +/- 0.9) and 7 without myalgia (5 M/2 F; age 58 +/- 3 years; weight 86 +/- 8 kg; BMI 28 +/- 2; fat % 31 +/- 3; FFM 60 +/- 5 kg; VAS 0.1 +/- 0.1) have completed the study. GIR values were similar, 11 +/- 1 and 13 +/- 1 mg/min/kg FFM, in the group with and without myalgia, respectively. By using FFM instead of body weight, we corrected for the differing body compositions between the male and female subjects, but GIR values per body weight were also similar. Discussion At this point, our results do not demonstrate any statistically significant differences in insulin sensitivity between the group with simvastatin-associated myalgia and the group without. Apart from the VAS-scores, groups were comparable for all parameters measured. Additional subjects are needed in order to draw any final conclusions. References (1) Franc S et al. (2003) *Cardiovasc Drugs Ther.* 17(5-6), p 459-465 (2) Mallinson JE et al. (2015) *J Physiol.* Contact mimmi@sund.ku.dk

## Oral presentations

### OP-PM10 Physiology: Age II

#### EFFECT OF HIGH INTENSITY TRAINING AND ISOINERTIAL TRAINING ON INTERMUSCULAR ADIPOSE TISSUE IN OLDER ADULTS.

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Introduction Recent findings suggest that, in elderly, Intermuscular Adipose Tissue (IMAT) may be associated with inactivity and that exercise training may be able to mitigate the content of IMAT (Murphy et al., 2012; Santanasto et al., 2011). The purpose was to determine how IMAT can be influenced by exercise and if a greater reduction in IMAT occurs with concurrent aerobic High Intensity Training (HIT) and Isoinertial Resistance Training (IRT). Methods 12 moderately active older adults (age: 69.4±4.3 yy; weight: 78.5±10.5 kg; height: 171.2±5.3 cm; BMI: 22.9±2.7 kg/m<sup>2</sup>; V<sub>O</sub>2max: 29.5±4.1 mL/kg/min) were exposed to 8 weeks of: i) HIT training with 7 two-minute cycling repetitions at 90% of V<sub>O</sub>2max, 3 times/week and, after 4 months, ii) IRT performed with an isoinertial leg press (YoYo Technology AB) comprised 4x7 maximal concentric-eccentric knee extensions, 3 time/week. MRI of the mid-thigh was examined to determine changes in muscle composition (Cross Sectional Area (CSA) and IMAT) after exercise intervention using SliceOmatic image analysis software (Rossi et al., 2010). IMAT was defined as adipose tissue area visible between quadriceps muscle groups. Results Quadriceps CSA increased

significantly after HIT and after IRT by 6% ( $P<0.05$ ) and 7% ( $P<0.05$ ) respectively. IMAT decreased after HIT and IRT by 31% ( $P<0.05$ ) and 41% ( $P<0.05$ ) respectively. Net thigh lean mass increased significantly after both training by 10% ( $P<0.05$ ). Discussion Our data, in contrast with Jacobs (2014) and Goodpaster (2008) but in agreement with other previous studies (Murphy et al., 2012; Santanasto et al., 2011), show that IMAT decrease after a 8 weeks exercise intervention in older adults both after HIT and IRT. Preliminary data show that exercise training performed at high intensity in older adults may contrast skeletal muscle fat infiltration. Our study is non-randomized, not-counterbalanced and limited by small sample size: additional studies are needed to determine the most effective exercise (type, intensity, modalities) able to decrease IMAT and how this decrease may positively affect health in elderly. References Goodpaster B, Chomentowski P, Ward B, Rossi A, Glynn NW, Delmonico MJ, Kritchevsky SB, Pahor M, Newman AB. (2008). *J Appl Physiol*, 105(5), 1498-1503. Jacobs JL, Marcus RL, Morrell G, LaStayo P. (2014). *Biomed Res Int*, 398960. Murphy JC, McDaniel JL, Mora K, Villareal DT, Fontana L, Weiss EP. (2012). *J Appl Physiol*, 112(1), 79-85. Rossi A, Zoico E, Goodpaster BH, Sepe A, Di Francesco V, Fantin F, Pizzini F, Corzato F, Vitali A, Micciolo R, Harris TB, Cinti S, Zamboni M. (2010). *Obesity*, 18(12), 2379-84. Santanasto AJ, Glynn NW, Newman MA. (2011). *Journal of Obesity*, 516576.

### **BLOCKING ANGIOTENSIN II TO IMPROVE THE ACUTE MUSCLE RESPONSE TO EXERCISE IN ELDERLY MEN**

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Title Blocking angiotensin II to improve the acute muscle response to exercise in elderly men Introduction The molecular mechanisms behind sarcopenia are largely unknown. Satellite cells (SC) are important for the plasticity and regenerative capacity of skeletal muscle and the decline in SC function with age is associated with increased Transforming Growth Factor-beta (TGF-beta) signalling [1]. Blocking Angiotensin II (AngII) in sarcopenic mice has been reported to downregulate TGF-beta and upregulate Insulin-like Growth Factor-1 (IGF-1) signalling in remodelling skeletal muscle [2], suggesting that blocking AngII could enhance muscle adaptation to loading. This has not previously been investigated in human skeletal muscles. The aim of this study was to investigate the effect of blocking AngII on the acute response of muscle to exercise in elderly men. Methods 26 elderly healthy men (+64 years) were recruited and assigned to an AngII blocker (Losartan) or Placebo group using stratified randomization according to age, BMI and ACE genotype. Losartan (100mg/day) or placebo was consumed for 18 days. Participants performed one bout of heavy one-legged resistance exercises, consisting of 5x12 repetitions of concentric work (70% of 1RM) and 4x6 repetitions of eccentric work (110% of 1RM). Six muscle biopsies were obtained from each subject from the Vastus Lateralis muscles: before (baseline) and after one week of treatment with Losartan, and after exercise at 4 hours and on days 1, 4 and 7. Blood pressure and blood samples were collected at the same six time points. Biopsies were sectioned and stained for Pax7, type I myosin and laminin for enumeration of SC associated with type I and type II fibres. mRNA levels of Tenascin-C, TGF-beta, IGF-1, and Collagen I were determined by real time PCR. Data were analysed by 1 or 2 way repeated measures ANOVA. Results There was no significant effect of Losartan on the SC response to exercise, but a main effect of time for SC per type I fibre was found, with increases on days 4 and 7 after exercise. No significant effect of Losartan was found for gene expression levels of Tenascin-C, TGF-beta, IGF-1, or Collagen I. Losartan treatment resulted in a small drop in diastolic blood pressure. Discussion Contrary to our hypothesis we did not find any effect of Losartan on the muscle response to acute exercise. However, it is possible that treatment and exercise over a longer period of time are required in order to be able to detect an effect. A study is currently underway to investigate this. References 1. Carlson, M.E., et al., *EMBO Mol Med*, 2009. 1(8-9): p. 381-91. 2. Burks, T.N., et al., *Sci Transl Med*, 2011. 3(82): p. 82ra37. Contact mette.flindt@regionh.dk

### **MATTERS OF FIBRE SIZE AND MYONUCLEAR DOMAIN; DOES SIZE MATTER MORE THAN AGE?**

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Introduction The relationship between skeletal muscle fibre size and myonuclear content is poorly understood, and may be influenced by ageing and life-long endurance exercise. Data from muscle biopsy cross-sections are typically reported as biopsy means, overlooking the great variability in fibre size (Mackey et al, 2014) and potentially the size-specific changes with age (Brack et al. 2005). The aim of this study was to gain more insight in the relationship between fibre size and myonuclei in a group of master athletes, age-matched controls and younger counterparts. Methods 49 subjects were recruited into 4 groups as young/old and endurance trained/untrained. A biopsy was obtained from the vastus lateralis muscle of each individual, sectioned and stained by immunohistochemistry for determination of fibre area and the number of myonuclei per fibre (MN/F). Myonuclear domain (MND) was calculated from these data. The MN/F and MND data were divided into clusters according to different ranges in fibre size: 3 large 2000  $\mu\text{m}^2$  clusters, and 20 small 500  $\mu\text{m}^2$  clusters. Clusters were analyzed by a 1-way ANOVA. Results The 2000  $\mu\text{m}^2$  analysis revealed that in fibres of comparable size there were no differences in MN/F or MND between the 4 groups. Therefore the groups were pooled, revealing a greater MN/F and a larger MND in medium vs. small fibres, but also in large vs. medium fibres. The 500  $\mu\text{m}^2$  analysis indicated a strong linear relationship between MN/F and fibre area. MND was non-linearly related to fibre area, with a markedly smaller domain in fibres <3000  $\mu\text{m}^2$ . A larger proportion of type II fibres <3000  $\mu\text{m}^2$  was observed in the old. Discussion In contrast to (Brack et al. 2005) we did not observe age-related differences in MN/F in fibres of similar size, and there was no effect of life-long endurance training on myonuclear content. The strong linear relationship between fibre size and MN/F indicate that changes in fibre size are followed by changes in myonuclear content (or the other way around). The MND findings suggest that age-related reductions in MND could be explained by a larger proportion of small fibres, and highlight the usefulness of fibre size-based clusters in gaining mechanistic insight into the relationship between skeletal muscle fibre size and myonuclear content. References Brack AS, Bildsoe H, Hughes SM. (2005), *Journal of Cell Science*, 118: 4813–4821. Mackey AL, Karlsen A, Couppé C, Mikkelsen UR, Nielsen RH, Magnusson SP, Kjær M. (2014). *Acta Physiologica (Oxford, England)*, 210: 612–627. Contact ak@anderskarlsen.dk

### **NO RESISTANCE EXERCISE INDUCED MUSCLE PROTEIN SYNTHESIS RESPONSE IN ELDERLY MEN AS COMPARED TO YOUNG**

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Introduction Young and elderly do not seem to have different basal muscle protein synthesis (MPS) rates (Volpi et al., 2001), however, elderly has shown diminished MPS responses to both exercise (Kumar et al., 2009) and essential amino acid feeding (Cuthbertson et al.,

2005). Therefore, the underlying mechanisms for age-related muscle loss may be reduced sensitivity to exercise and feeding. We hypothesized that a more severe exercise program might enhance exercise-related MPS sensitivity in elderly. Aim of this study was to measure MPS at normal and following a 4-d severe heavy resistance exercise program in groups of young and elderly men. Methods 8 young ( $23 \pm 1$  y (mean  $\pm$  SE),  $24.1 \pm 0.9$  kg/m<sup>2</sup> BMI) and 8 elderly ( $70 \pm 1$  y,  $26.1 \pm 0.8$  kg/m<sup>2</sup> BMI) men were recruited and underwent a 4-d unilateral heavy resistance exercise program. Exercise consisted of leg press and leg extension, each 3–4 sets at 8–10 RM, and was performed every day in 4 days. Muscle biopsies were taken from vastus lateralis in the normal and exercised legs at day 2 prior to exercise and again following exercise and a 4-h flood primed, continuous infusion of L-[ring-<sup>13</sup>C<sub>6</sub>]phenylalanine at day 4 to measure and calculate normal and exercise myofibrillar fractional synthesis rates (FSR). Blood samples were collected during the infusion trial at 1 h intervals. Results Myofibrillar FSR were in the normal and exercised state  $0.039 \pm 0.003$  %/h and  $0.057 \pm 0.003$  %/h in young, and  $0.044 \pm 0.004$  %/h and  $0.048 \pm 0.002$  %/h in elderly. 2-way ANOVA (state repeated, group non-repeated) revealed a significant interaction ( $P = 0.039$ ). Student Newman-Keuls post hoc test showed no difference in normal FSR between young and elderly, but only young had increased FSR in the exercised muscle ( $P < 0.001$ ). Discussion Young and elderly men have equal normal myofibrillar protein synthesis rates, but the elevated response to 4 heavy resistance exercise bouts on 4 consecutive days is only manifest in the young individuals. Therefore, it can be concluded that a 4-d severe heavy resistance exercise program is not capable of inducing an anabolic response in elderly men, at least in the overnight fasted state. References Cuthbertson D, Smith K, Babraj J, Leese G, Waddell T, Atherton P, Wackerhage H, Taylor PM, Rennie MJ (2005). *FASEB J* 19: 422–424. Kumar V, Selby A, Rankin D, Patel R, Atherton P, Hildebrandt W, Williams J, Smith K, Seynnes O, Hiscock N, Rennie MJ (2009). *J Physiol* 587: 211–217. Volpi E, Sheffield-Moore M, Rasmussen BB, Wolfe RR (2001). *JAMA* 286: 1206–1212. Contact E-mail: s.reitelseder@sund.ku.dk

### EFFECTS OF EXERCISE ON HAEMATOLOGICAL CHANGES OF ELDERLY PERSONS

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Introduction Hematopoietic modulation can become unstable with aging. The data provided by the complete blood count (CBC) in this case are essential within the investigation of hematologic diseases. The diversity of information that the CBC can provide makes this one of the most requested subsidiary examination in clinical and surgical practices. Peripheral blood alterations in aging include discrete and isolated elevations in the erythrocyte sedimentation rate, mild lymphocytopenia without clinical and laboratory manifestations, and decreased mean hemoglobin and hematocrit concentrations (Sgnaolin et al. 2013). However, little is known about the effects of an exercise program on quantitative and morphological variation of elements in the blood, especially in elderly individuals. The aim of this study was to verify hematologic changes in elderly women due to the practice of two different exercise programs in a period of 28 weeks. Methods Fifty-four ( $n=54$ ) elderly women divided in three groups designated Aerobic/Walking Exercise (AWE,  $n=21$ ), Yoga/Flexibility (YF,  $n=24$ ) and Control Group (CG,  $n=9$ ) had a CBC done before (M1) and after (M2) a period of 28 weeks. During this period the AWE and YF programs were implemented and the subjects exercised 2–3 times per week, at low/moderate intensity. Results The analyses of leucocytes, red cells indices and platelet series in blood demonstrated that there are no significant differences ( $p > 0.05$ ) in the variables of the CBC when the two moments of the collection data were compared. However, a slight decrease occurred in the average values for white blood cells counts in the CG. Discussion There were no significant changes in any variables of the CBC for the groups that performed the exercise programs. The main changes occurred in the CG, where a decrease in the number of leukocytes was observed after the seven months. Previous evidence has shown that immune system maintenance is expected with the regular practice of physical exercises (Simpson et al. 2012), which corroborates the results of this research. Aging-associated changes in monocyte and macrophage function have been recognized as major contributors to dysregulation of the immune system in a variety of disease processes (Desai et al. 2010). In our study, we saw that decreases in monocyte counts occurred with more incidence in sedentary CG than in those that participated in the low/moderate intensity exercise programs. References Desai, A. et al. (2010). Leukocyte function in the aging immune system. *J Leukoc Biol*, 87(6):1001–9 Simpson, R.J. et al. (2012). Exercise and the aging immune system. *Ageing Res Rev*, 11(3): 404–20 Sgnaolin, V. et al. (2013). Hematological parameters and prevalence of anemia among free-living elderly in south Brazil. *Rev Bras Hematol Hemoter*, 32(2):115–118

### ANABOLIC EFFECTS OF LIGHT LOAD RESISTANCE EXERCISE AND DISTRIBUTION OF PROTEIN INTAKE IN ELDERLY – WITH EMPHASIS ON MUSCLE PROTEIN SYNTHESIS REGULATION AND AMINO ACID TRANSPORTERS

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Introduction The present study investigated whether well-tolerable light-load resistance exercise (LL-RE) affects skeletal muscle fractional synthetic rate (FSR) and anabolic intracellular signalling as a way to counteract anabolic resistance and age related loss of muscle mass. Furthermore, we explored whether LL-RE affected post-prandial amino acid transporter (AAT) expression in ageing skeletal muscle, thus altering amino acid sensing. Methods Untrained healthy men (age: +65 years) were subjected to 13 hours of supine rest with infusion of a stable amino acid tracer (ring-<sup>13</sup>C<sub>6</sub>-phenylalanine). After 2½ hours of rest, unilateral LL-RE was conducted (leg extensions; 10 sets, 36 repetitions) at 16% 1RM. Hereafter, the subjects were randomised to oral intake of 700 mg/kg fat-free mass (~40g) whey-protein either as hourly drinks (~4g per drink) (PULSE,  $n=10$ ) or two boluses (~28g at 0h and ~12g at 7h) (BOLUS,  $n=10$ ) or isocaloric maltodextrin (~4g/hour) (Placebo,  $n=10$ ). Quadriceps muscle biopsies were taken at 0, 3, 7 and 10 hours post-exercise from both the resting and exercised leg. Myofibrillar-FSR, activity through mTORC1-signalling cascade and membrane-associated protein expression of select AATs involved in mTORC1 activation were analysed from the biopsies. Results LL-RE increased myofibrillar-FSR compared to the resting leg in all groups. p-AKT (T308) expression increased in the exercise leg immediately after exercise, which in the Placebo-group persisted throughout the post-exercise period, reflecting plasma insulin levels. p-4E-BP1 (T37/46) increased throughout the post-exercise period in the exercised leg in Placebo and BOLUS group and peaked at 7h. p-eEF2 (T56) decreased in response to LL-RE in all three groups. An increase in AAT expression was only observed when LL-RE was followed by whey-protein intake and reflected changes in plasma amino acid concentrations. Specifically, LAT1 and PAT1 expression increased in PULSE and PAT1 expression increased in BOLUS. Conclusion Resistance exercise at only 16% 1RM increased myofibrillar-FSR, irrespective of nutrient type and feeding pattern, which indicate an anabolic effect of LL-RE in elderly. This finding was supported by increased signalling for translation initiation and translation elongation in response to LL-RE. The Placebo group had a greater signalling through AKT, whereas LL-RE increased membrane-associated AAT protein expression in whey-protein groups (PULSE and BOLUS), making the muscles more susceptible to amino acids and increasing the potential for mTORC1-signalling.

## Oral presentations

### OP-PM14 Physiology: Interval training

#### THE EFFECT OF COLD-WATER IMMERSION ON THE CHANGE IN SKELETAL MUSCLE NA<sup>+</sup>-K<sup>+</sup>-ATPASE GENES FOLLOWING INTENSE INTERMITTENT EXERCISE IN HUMANS

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Introduction The Na<sup>+</sup>-K<sup>+</sup>-ATPase (NKA) is known as a key regulatory protein influencing skeletal muscle function, and its adaptability at both the gene and protein level appears of functional relevance to intense, human exercise performance [1, 2]. Developing strategies to augment the muscular adaptations specific to the NKA genes would therefore seem of interest. Research suggests that NKA genes may be augmented by cellular hypoxia and the subsequent creation of reactive oxygen species [3, 4] and hyperoxia [5]. Given the potential of cold-water immersion to promote these cellular stressors [6], we therefore evaluated the hypothesis that CWI could amplify the induction of NKA genes in human skeletal muscle in response to a single session of intense intermittent exercise. Methods Nineteen males with an age and VO<sub>2</sub>peak (mean ± SD) of 24 ± 6 years and 46.5 ± 8.1 mL·kg<sup>-1</sup>·min<sup>-1</sup>, respectively, completed an intense interval exercise session consisting of four 30-s 'all-out' efforts on a cycle ergometer, which was followed by one of two 15-min recovery interventions: cold-water immersion (CWI, n = 9; 10.3 ± 0.2°C) or rest at room temperature (CON, n = 10; 23.0 ± 0.1°C). Muscle were sampled at rest before exercise, and immediately and 3-h post recovery, in order to compare the changes in NKA genes following CON and CWI. Results At 3-h post recovery, the relative mRNA expression of the NKA catalytic α1 and structural β3 isoforms was increased (P<0.05) in both groups (CON: ~1.5- and ~2.1-fold, ES = 0.6 and 1.2; CWI: ~1.9- and ~2.8-fold, ES = 0.8 and 1.6, respectively), with the rise in β3 mRNA being of greater magnitude in the CWI group compared to CON (P<0.05). No changes in α1 and β3 mRNA occurred at any other time points relative to before exercise. The mRNA expression of the remaining isoforms remained unchanged in both groups following the exercise session. Discussion This study is the first to demonstrate that CWI can enhance the induction of the Na<sup>+</sup>-K<sup>+</sup>-ATPase β3 gene in human skeletal muscle in response to a one-off intense interval exercise session. These data provide a basis for studying the structural and functional adaptations associated with muscle ion transport, as well as possible performance alterations, following a period of post-exercise CWI. References 1. Aughey et al., 'Muscle Na<sup>+</sup>-K<sup>+</sup>-ATPase activity and isoform adaptations..'. JAP, 2007. 103(1): p. 39-47. 2. Iaia, et al., 'Reduced volume but increased training intensity..'. Am J Physiol Regul Integr Comp Physiol, 2008. 294(3): p. R966-74. 3. Clanton, Hypoxia-induced reactive oxygen species formation in skeletal muscle. JAP, 2007. 102(6): p. 2379-88. 4. Murphy et al., 'Antioxidant treatment with N-acetylcysteine..'. Exp Phys, 2008. 93(12): p. 1239-48. 5. Wendt, et al., 'Up-regulation of Na,K-ATPase beta 1 transcription..'. J Biol Chem, 2000. 275(52): p. 41396-404. 6. White, G.E. and G.D. Wells, 'Cold-water immersion and other forms of cryotherapy..'. Extrem Phys Med, 2013. 2(1): p. 26.

#### HIGH-INTENSITY EXERCISE, LACTATE SHUTTLE THEORY AND TUMOUR METABOLISM – A THEORETICAL APPROACH

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Strategies to disrupt pH control were widely suggested to be effective to positively influence aggressive glycolytic tumours (7). Evidence was provided for aerobic exercise training to modulate several host- and tumour-related pathways (6). It was suggested "... that exercise may do more than decrease symptoms and improve quality of life for cancer patients" (1) but the optimum amount of intensity and duration is still unknown. According to the lactate shuttle theory three phases of metabolism can be determined (2). These three distinct metabolic patterns allow prescribing defined workloads such as low (LO), moderate (MO) or high exercise (HI) with either lactate consuming or lactate producing conditions (5). As manipulating the tumour acidification may be a cancer treatment strategy at least to improve therapy resistance (7) exercise prescription may be crucial. Contrary to the mainly prescribed MO intensity for cancer patients, two main intensity domains are suggested to be relevant with respect to tumour metabolism, tumour-host interaction and host stability namely LO and HI exercise. LO is set below the first lactate (La) turn point indicated by whole body La oxidation rate exceeding the local La production rate (= reduction of elevated systemic blood La concentration) and HI is set above the second La turn point inducing a high systemic La acidosis which in turn inhibits glycolytic La production within every cell relying on anaerobic glycolysis (5). We recently showed in healthy subjects that the elevations of La by means of all out hand crank exercise reduced net-La increase in a subsequent HI anaerobic leg exercise by 50% (4). The functionality of these principles was shown for LO (9) and HI (3) exercise in tumour models. LO resulted in decreased tumour angiogenesis, an increase in oxygenation, reduced La concentration in the tumour micro-environment and a normalization of pH in tumour-bearing host. HI anaerobic exercise was shown to decrease tumour growth, cancer cachexia and increased innate and adaptive immune function in rats. Effects of exercise on cancer progression, and metastasis in a murine prostate cancer model were tumour vascularisation and a shift towards suppressed metastasis (6). Episodic, transient systemic acidosis was suggested to delay the evolution of the malignant phenotype (8). A multi-modal approach combining LO and HI components is therefore suggested to be an optimal model. Conclusion LO and HI exercise were shown to be effective to influence tumour growth and the tumour-host interaction but studies in eligible patients on the direct influence on tumour metabolism as well as tumour-host interaction of defined exercise intensities and modes are needed. References At the author Contact [peter.hofmann@uni-graz.at]

#### HIGH INTENSITY INTERVAL TRAINING ATTENUATES INSULIN RESISTANCE INDUCED BY SLEEP DEPRIVATION

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Introduction Several studies have shown that sleep deprivation promotes negative influences on carbohydrate metabolism resulting in insulin resistance and increases risk of type 2 diabetes mellitus. On the other hand, physical exercise has been considered as a non-pharmacological strategy to glycemic control. Thus, the aim of this study was to analyze the effects of high intensity interval training (HIIT) on the blood glucose, insulin and free fatty acids (FFA) concentrations. Methods Eleven male volunteers, young and healthy were submitted to four conditions: Regular Sleep (RS), Sleep Deprivation (SD), HIIT + Regular Sleep (HIIT+RS) and HIIT + Sleep Deprivation (HIIT+SD). HIIT protocol consisted of 6 training sessions in two weeks, and after this period the volunteers slept normally or were deprived of sleep for 24 consecutive hours in a cross-over type design. We evaluated the concentrations of FFA in the blood and the insulin sensitivity was evalu-

ated by Oral Tolerance Glucose Test (OGTT) (NCT02125656). Results The area under the curve of glucose was 83% higher in SD condition when compared to RS condition (RS =  $360.7 \pm 62.2$ ; SD =  $432.2 \pm 87.6$ ; HIIT+RS =  $403.1 \pm 69.9$ ; HIIT+SD =  $377.1 \pm 46.5$ ) and the area under the curve of insulin was 60% higher when compared to the other conditions (RS =  $83.9 \pm 44.7$ ; SD =  $134.6 \pm 61.1$ ; HIIT+RS =  $79.0 \pm 27.3$ ; HIIT+SD =  $81.4 \pm 32.9$ ). Furthermore, FFA was 187% higher in SD condition when compared to RS condition (RS =  $280.7 \pm 100.8$   $\mu\text{mol/L}$ ; SD =  $525.6 \pm 235.0$   $\mu\text{mol/L}$ ; HIIT+RS =  $389.2 \pm 202.23$   $\mu\text{mol/L}$ ; HIIT+SD =  $425.7 \pm 194.4$   $\mu\text{mol/L}$ ). Discussion Sleep deprivation was able to increase the area under the curve of glucose and insulin, confirming the literature data showing that sleep debt has a negative impact on carbohydrate metabolism (Klingenberg et al, 2013). Insulin resistance can be explained by the increase of FFA in the bloodstream, resulting in an impairment in insulin signaling (Boucher et al., 2015). However, when the volunteers practiced previously HIIT sleep deprivation, the exercise proved to be a beneficial strategy for glycemic control. The HIIT is able to enhance expression of GLUT4 and AMPK (Gibala et al., 2009), increase mitochondrial biogenesis and the oxidation of FFA (Burgomaster et al., 2008), minimizing the insulin resistance observed in sleep deprivation. References Boucher J, Kleinridders A, Kahn CR. (2014). *Cold Spring Harb Perspect Biol.* 1, 1-6. Burgomaster KA, Howarth KR, Phillips SM, Rakobowchuk M, Macdonald MJ, McGee SL, Gibala MJ. (2008). *J Physiol*, 586(1), 151-60. Gibala MJ, McGee SL, Garnham AP, Howlett KF, Snow RJ, Hargreaves M. (2009). *J Appl Physiol*, 106(3), 929-34. Klingenberg L, Chaput JP, Holmbäck U, Visby T, Jennum P, Nikolic M, Astrup A, Sjödin A. (2013). *Sleep*, 36(7), 1085-1090. Contact jorge.fernando22@hotmail.com

## EFFECTS OF AGE AND SEX ON THE MECHANICAL CHARACTERISTICS OF THE KNEE JOINT EXTENSORS

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1: Institute for Sport and Health, University College Dublin, Ireland, 2: School of Electrical, Electronic and Communications Engineering, University College Dublin, Ireland, 3: Department of Sport, Health and Exercise Science, University of Hull, United Kingdom Introduction Age-related decreases in muscle strength can be explained to a great extent by changes in the mechanical characteristics of the musculoskeletal system. Other "mechanical factors" such as muscle architecture (MA) and tissues stiffness significantly contribute to force generation and transmission. Experimental evidence has shown that these properties exhibit considerable plasticity, undergoing changes with aging. Therefore, the aim of this study was to compare and contrast the mechanical properties of the knee extensor musculature in young (Y) and older (O) males and females. Methods 22 Y (11 Females, 23.9+3.4 years; 11 Males, 24.3+4.2 years) and 20 O (9 Females, 66.3+4.4 years; 11 Males, 66.9+3.5 years) subjects participated. MA parameters of vastus lateralis (VL) were obtained by ultrasonography. Knee-extensor maximum voluntary isometric contraction (MVIC) was measured on a leg-extension dynamometer. Muscle stiffness (MS) of the VL was obtained by myotonometry (relaxed and at 20% MVIC) whilst musculo-articular stiffness (MAS) was evaluated via the free-oscillation technique (at 20% MVIC). Results Males were characterized by a larger decline in MVIC (42.94%) compared to O females (30.27%) with main effects observed for age (Y=239.5+90.6, O=150.3+49.0Nm; P<.001) and sex (Males=234.2+90.4, Females=156.2+54.0 Nm; P<.001). Concerning VL thickness main effects were observed for age (Y=22.8+3.2, O=19.5+2.0mm, P<.001) and sex (Males=22.3+3.4, Females=20.1+2.4mm; P<.01). For VL fascicle length there was a main effect for age (Y=104.8+12.1, O=89.8+10.5mm, P<.001). Regarding VL pennation angle there was a main effect for sex (Males=13.5+2.7, Females=11.0+1.8°, P<.001). MS relaxed demonstrated a main effect for age (Y=379.8+36.2, O=342.5+36.4N/m; P<.001) and sex (Males=377.7+35.3, Females=344.9+39.6N/m; P<.01). MS contracted was characterized by a significant main effect for sex (Males=479.0+46.3 Females=410.3+63.6N/m; P<.001). For MAS a significant main effect was observed for age (Y=977.6+435.0, O=551.4+191.2N/m; P<.001) and sex (Males=898.8+437.9, Females=638.1+310.6N/m; P<.01). Discussion The main finding of this study is that there is a significant age-related decrease in the mechanical properties of the knee joint extensor musculature in both males and females, with a more evident reduction observed in males. Overall, our results suggest that age-related changes in the mechanical characteristics of knee extensors impair the execution of motor tasks in both sexes with a more pronounced effect in males. rui.wu.1@ucdconnect.ie

## EXERCISE INDUCED BRONCHOCONSTRICTION IN CHILDREN WITHOUT ASTHMA

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Introduction Exercise induced bronchoconstriction (EIB) is common in asthma and may be associated with inactivity and overweight. EIB may, however, also be prevalent in non-asthmatic children. We aimed to investigate whether EIB was associated with baseline lung function, overweight or self-reported physical activity (PA) in non-allergic, non-asthmatic children. Methods The present study included 432 children from the Environment and Childhood Asthma birth cohort study (mean age 10.7, 46% boys) who had no doctor's diagnosis of asthma, no self-reported wheeze during the last 12 months, no use of asthma medications and negative skin prick test for allergy. Lung function (forced expiratory flow at 1 second (FEV1), forced expiratory flow at 25-75% of FEV1 (FEF25-75), forced vital capacity (FVC), and FEV1/FVC) were measured and calculated according to international standards. Overweight were defined according to age and gender adjusted body mass index according to Cole et al (2000). All completed a standardized EIB challenge test, regarded positive with a fall in FEV1 of at least 10 percent, and a questionnaire regarding physical activity and participating in sports. Results were compared using Chi-square tests for categorical and independent t-tests for continuous variables. Multivariate associations were analyzed in a logistic regression model, removing the least significant variable stepwise until only significant variables remained. Results Fifty-seven children (13%) had a positive EIB-test. Mean baseline FEV1 were 98 ( $\pm 9$ ), mean body mass was 38 ( $\pm 8$ ) kg and height 145 ( $\pm 7$ ) cm, and mean hours/week participating in sports were 2.13 ( $\pm 1.54$ ). Lung function was similar in children with and without EIB. Children with compared to without EIB were significantly more often overweight (25% vs. 12%,  $p=0.01$ ), and spent significantly less time in sports (mean hours 1.71, (95% confidence interval (CI); 1.37, 2.06) /week vs. 2.19, (2.11, 2.35),  $p=0.03$ ). In final multivariate analysis adjusted for gender, overweight children were more likely to have a positive EIB (Odds ratio; 2.47, (95% CI 1.24, 4.92)) whereas children doing one or more hour sports/week were less likely (0.80 (0.65, 0.98)) to have EIB. There was no significant interaction between overweight and hours participating in sports. Discussion Exercise induced bronchoconstriction that was relatively common in non-asthmatic subjects, was associated with being overweight as well as spending less time in sports than subjects without EIB. This suggests that EIB may be a barrier not only to PA but to participation at possibly lower intensity, also in children without recognized asthma. References Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal*, 1240-1243. Contact thomas.westergren@uia.no

## EXERCISE EFFICIENCY IS INCREASED WITH AGE BUT NEITHER DETERMINED BY FIBRE-TYPE DISTRIBUTION, MITOCHONDRIAL FUNCTION NOR CITRATE SYNTHASE ACTIVITY

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Whether exercise efficiency (EE) is increased with age is a matter of debate and hence also the potential mechanisms that may facilitate this remain disputed. Accordingly, the purpose of this study was to determine if EE is altered in aged humans and to test whether changes can be related to skeletal muscle properties. Peak oxygen uptake (VO<sub>2peak</sub>) and EE were assessed with an incremental cycling test in 11 young (YNG, 27 ± 4 yrs) and 13 old (OLD, 65 ± 4 yrs) individuals. With the intent to reduce the possible confounding factor of training status, VO<sub>2peak</sub> of OLD were adjusted for age by subtracting 4 ml/kg/min per decade (Wilson and Tanaka, 2000) and subsequently matched to YNG. EE was calculated as the mean ratio of work and energy expenditure at ~50, 60, 70 % VO<sub>2peak</sub> (on the basis of Coyle et al., 1992). Skeletal muscle biopsies were obtained from the m. vastus lateralis for the evaluation of muscle fibre-type distribution (% slow-twitch, ST; % fast-twitch, FT), citrate synthase (CS) activity as a marker of mitochondrial content, maximal mitochondrial respiratory capacity (OXPHOS) and mitochondrial efficiency (MitEFF). EE was higher in OLD vs. YNG (16.7 ± 1.5 vs. 14 ± 2.4 %, P < 0.01). There was no effect of age on % ST and FT (60.2 ± 11.9 vs. 53.4 ± 10.9 %, P = 0.161; 39.8 ± 11.9 vs. 46.6 ± 10.9 %, P = 0.162) or on CS activity (168.3 ± 32.6 vs. 144.8 ± 25.7 μmol/ml/min, P = 0.066). OXPHOS, OXPHOS per CS activity, MitEFF and MitEFF per CS did not differ between OLD and YNG (93.5 ± 16.7 vs. 91 ± 12.7 pmol O<sub>2</sub>/mg/s, P = 0.690; 56.6 ± 10 vs. 65.2 ± 17.2 %, P = 0.135; 35.7 ± 4.2 vs. 36.6 ± 8.6 %, P = 0.749; 22 ± 5 vs. 25.8 ± 6.5 %, P = 0.117). Neither of the tested variables correlated to EE. EE was higher in OLD vs. YNG at comparable fitness levels, which extends previous findings by accounting for the age-dependent decrease in VO<sub>2peak</sub>. Furthermore, EE was higher in OLD vs. YNG after controlling for % ST, FT, CS activity, OXPHOS or MitEFF. Accordingly, these findings suggest that with older age the energetic needs are met with a smaller perturbation of intracellular metabolism. Coyle EF., Sidossis LS., Horowitz JF., Beltz JD. (1992). *Med Sci Sports Exerc*, 24: 782-788. Wilson TM., Tanaka H. (2000). *Am J Physiol Heart Circ Physiol*, 278: H829-834.

## Oral presentations

### OP-PM68 Adapted Physical Activity: Physical disabilities

#### SPORT PARTICIPATION OF DISABLED CHILDREN IN KOSOVO

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This research titled sport participation of disabled children in Kosovo presents results from a study performed with young people with disability and from an interview with a sport physical education teacher who works with those children. Being concerned with these children experiences of sport and participation in sport this research investigated the barriers that these children experience to participation in sport. The aim of this research was to help Ministry of Youth, Culture and Sport, teachers and others to make better investment in sport for people with disabilities. The accessibility of public facilities for people with disabilities in Kosovo is nearly impossible not just in sports facilities but also accessing on the roads, in coffee bars, restaurants and public transportation. This study has been done with a mixed research paradigm. The combination of quantitative and qualitative methods. The literature review has been performed with the focus of a wide range of literature for sport and disabled people and especially about participation in sport. In the current study have been used three methods to collect data: questionnaires that were completed by children, individual interview with physical education teacher, and observations that were done in the classrooms. This study has gathered and analyzed evidence relating to pupils and physical education teacher's views pupils' participation in sport. This study has produced clear evidence that the main barriers for not participating in sport is the low economical condition of our country, low economical condition of the families, lack of facilities, society and support of institutions.

#### THE PROGRESSION OF SPRINT PERFORMANCES IN BLADE RUNNERS

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**INTRODUCTION** Similarly to able-bodied sport, technological advances in sporting equipment is also evident in sport for athletes with disabilities. One of the prominent developments involves the running specific prosthesis (RSP) used by athletes with lower limb amputations. For these athletes, the RSP not only affects his/her performance, but essentially enables the athlete to run. It is reasonable to think that RSP's had similar ergogenic effects on Paralympic sprinters than technical swimsuits on Olympic swimmers, albeit not necessarily to the same extent. The purpose of this study was to investigate the performance changes in athletes with lower limb amputations since 1992 to assess whether the developments in RSP technology is evident in sprinting performances. **METHODS** Results for the Olympic and Paralympic Games from 1992 to 2012 for sprint athletes in the T12, T13, T37, T42 and T44 classes were gathered from two websites(1, 2). Athletes' performances in the Olympic Games were included as reference points to assist in the interpretation of changes in the T42 and T44 performances. The descriptive statistics (means, standard deviations and percent change) were calculated from the race times. Competition density (CD) was calculated to illustrate the competitiveness of each event. High values indicate that competitors completed the race close together and vice versa. **RESULTS** The greatest performance increases were seen in athletes with lower limb amputations (T42 = 26%, T44 = 14%). These performance improvements were greater than for Olympic athletes (< 3%), as well as Paralympic athletes with visual impairments and cerebral palsy (< 10%). In both the 100m and 200m the Olympic results were most dense (23.90 and 9.29 competitors.s-1), respectively, whereas the T42 class was the least dense in both events (100m = 4.53 competitors.s-1; 200m = 1.93 competitors.s-1). **DISCUSSION** The performance trends for Paralympic athletes with lower limb amputations suggest that RSP technology almost certainly played a significant role in the advancement of their performances until 2012. A further indication of the importance of RSP technology in the performances of these athletes is that athletes who are more dependent on RSPs for locomotion (i.e. athletes with above knee amputations) showed the largest improvements in performance, as well as greater variation among athletes in a race. For athletes to remain competitive, they will not only need access to the latest RSP technology, but they will also need the scientific backup to match him/her with the most appropriate RSPs for the specific event. **REFERENCES** 1. Wagner J. Olympic games museum [Online]. 2014

[access 2014, August 6]; Available: <http://www.olympic-museum.de/index.html> 2. IPC Historical results database [Online] 2012 [access 2014, August 6]; Available: <http://www.paralympic.org/results/historical>

## ELITE ICE SLEDGE HOCKEY PLAYERS DO NOT DIFFER FROM ABLE-BODIED CROSS-COUNTRY SKIERS IN EXERCISE EFFICIENCY

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**Introduction:** Exercise efficiency (EE), which is the ratio of work rate (WR) generated to the energy expended, is a key factor for aerobic endurance performance. EE is, therefore, suggested to be of importance in ice sledge hockey, where most of the game is spent upper-body poling at submaximal intensities, as well as in cross-country skiing, where comparable upper-body poling is executed at high continuous aerobic endurance levels. Although the training of both groups comprises large amounts of poling-specific upper-body endurance exercise, it remains unclear if the disabilities of the ice sledge hockey players (ISH) affect EE. Therefore, the purpose of this study was to investigate possible differences in EE between elite ISH and cross-country skiers (XC). **Methods:** 9 male elite ISH (training/year: 550±126.5hrs) and 13 male elite able-bodied XC (training/year: 612±37hrs) of similar age and weight performed 3x4-min submaximal stages of upper-body poling on a modified Concept2 ski ergometer, while sitting in an ice sledge hockey seat. Additionally, peak aerobic capacity (VO<sub>2</sub>peak) was determined from a 3-min all-out test in the same exercise mode. The 3 submaximal stages corresponded to a %VO<sub>2</sub>peak of approximately 55 (SUB1), 65 (SUB2) and 80% (SUB3). A steady state WR was maintained throughout each stage and recorded by the ergometer's internal software. The metabolic rate (MR) was calculated as the energetic equivalent of the mean VO<sub>2</sub> during 60-s (L·min<sup>-1</sup>) and the corresponding respiratory exchange ratio. Linear regression analyses were performed to identify the WR-MR relationship for ISH and XC. To test for differences in the inclines of the two regression lines an ANCOVA was performed. **Results:** The mean WR for ISH and XC was 40±11 and 68±8W at SUB1, 54±14 and 92±12W at SUB2 and 72±22 and 119±21W at SUB3, respectively. The corresponding MR values were 428±72 and 629±106 at SUB1, 530±78 and 792±154 at SUB2, and 683±215 and 997±187 at SUB3. The VO<sub>2</sub>peak differed significantly between ISH (2.5±0.5L·min<sup>-1</sup>) and XC (3.6±0.8L·min<sup>-1</sup>) (p=0.001). The regression lines identified for ISH (y=131+7.5x, R<sup>2</sup>=0.80) and XC (y=108+7.5x, R<sup>2</sup>=0.80) did not significantly differ (p=0.991). **Conclusion:** EE in upper-body poling was not different between ISH and XC and, therefore, not significantly influenced by the disabilities in our ISH sample. The current data indicates that the higher work rates produced by XC are related to the higher VO<sub>2</sub>peak instead. The difference in VO<sub>2</sub>peak may be attributed to the varying sport-specific demands and, more importantly, to the possibility of the XC skiers to regularly execute whole-body endurance exercise.

## HOW CAN SPORT CLUBS FOR NON-DISABLED YOUTH INCLUDE CHILDREN AND ADOLESCENT WITH DISABILITIES?

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**Introduction** Young people with disabilities participate in sports to a lesser extent than other adolescents [1]. That physical activity has positive effects on children and adolescents, such as reduced risk of diabetes, overweight and obesity, anxiety and depression are understood [2]. The positive effects of participation in organized sport and physical activity are at least as great for children and young people with disabilities as children and young people without disabilities. One of the most important tasks of various actors is to find ways to increase physical activity and the health of children and youth with disabilities. Sports clubs are identified as potential and attractive environments for physical activity, but also for social and mental health [3]. The reasons why children and young people with disabilities participate to a lower extent in organized sport is complex and barriers can be deriving from many different levels. However, barriers have been studied more than what can facilitate participation in organized sport [4]. Therefore the aim of this study is to present the first results from a systematic international and scientific literature review of how sport clubs for non-disabled youth can include children and adolescents with disabilities in their activities. **Method** Articles (with inclusion criteria of studies focusing on children and adolescents, disability, physical activity, engagement in organized sports, inclusive sport settings) from a 20 years period were selected. Studies with topics that concerned physical education, medical, physical activity without an organized sport agenda, elite sport or equipment issues were excluded. **Results** The results will focus on which type of sport, target group and countries the examples are from, but foremost on how sport clubs for non-disabled youth actually do to include children and adolescents with disabilities in their activities. **Discussion** It is essential to establish a knowledge base for as well methods for inclusion in everyday activity, as effective interventions towards the target group at hand. If more children and youth with disabilities participate in organized sports several positive health benefits can be achieved. **References** [1] Ungdomsstyrelsen, Levnadsvillkor för unga med funktionsnedsättning, FOKUS12, Stockholm. [2] World Health Organization, Global recommendations on physical activity for health. 2010: Geneva. [3] EU, White Paper on Sport, Commission of the European communities, 2007. [4] Shields, N., A.J. Synnot, and M. Barr, Perceived barriers and facilitators to physical activity for children with disability: a systematic review. *British Journal of Sports Medicine*, 2012. 46(14): p. 989-997. Contact kajsa.Jerlinder@hig.se

## Oral presentations

### OP-PM56 Health & Fitness: Endurance

#### POSTURAL CONTROL AFTER ENDURANCE EXERCISES AT DISTINCT INTENSITIES

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**Introduction** Endurance exercise can affect postural sway. Fatiguing incremental exercise increases postural sway. However, results about effects of different levels of exercise intensity in particular related to measures of energy metabolism are inconsistent and rare (Paillard 2012). Additionally, diversity of methods used to evaluate postural sway limits comparability. Purpose of this study was to investigate effects of cycling exercises at three distinct intensity domains as indicated by metabolic conditions on postural sway in bipedal stance without and with visual deprivation. **Methods** 23 regularly physically active participants (10 males, 13 females; 23.7±1.6 yr; 177±9 cm; 74±12 kg) performed an exhausting incremental cycle ergometer test followed by four 20 min constant load tests at exercise intensi-



ties corresponding to 2, 3, 4 and 5 mmol/l blood lactate concentration (BLC) of the incremental test in randomised order. The exhausting incremental test, the lowest completed 20 min constant exercise at which the BLC showed no steady state by increasing until test termination (severe), and the 2 mmol/l intensity test showing a constant steady state BLC response after some variability during the initial 10 min (moderate) were taken for analysis (Bencke 2003). Postural sway in terms of the 95% ellipse area of center of pressure (CoP-area) was measured immediately before (pre) and 1 min after (post) each exercise for 30 sec in barefooted bipedal stance (bi) with eyes open (eo) and closed (ec). Results CoP-area shows main effects for pre-post in both bipedal stances (bieo: pre  $1.30 \pm 0.70 \text{ cm}^2$ , post  $2.05 \pm 1.51 \text{ cm}^2$ ;  $p \leq 0.001$ ; biee: pre  $1.26 \pm 0.61 \text{ cm}^2$ , post  $1.80 \pm 1.43 \text{ cm}^2$ ;  $p \leq 0.001$ ), interaction effects with energy metabolism (bieo  $p \leq 0.05$ ; biee  $p \leq 0.01$ ) and a main effect of energy metabolism in bieo ( $p \leq 0.05$ ). Exhausting exercise increased CoP-area of both stances (bieo: pre:  $1.31 \pm 0.69 \text{ cm}^2$ , post:  $2.67 \pm 1.34 \text{ cm}^2$ ;  $p \leq 0.001$ ; biee: pre:  $1.21 \pm 0.58 \text{ cm}^2$ , post:  $2.30 \pm 1.95 \text{ cm}^2$ ;  $p \leq 0.01$ ), whilst severe exercise increased CoP-area in biee (pre  $1.06 \pm 0.40 \text{ cm}^2$ ; post  $1.73 \pm 1.33 \text{ cm}^2$ ;  $p \leq 0.05$ ) only. Moderate exercise had no effect on postural sway. Conclusion Exhaustive exercise increased postural sway irrespective of visual input. Visual control seems to be required for preventing increase in postural sway after non-exhaustive effort of 20 min duration in the severe intensity domain, but not after moderate exercise of similar duration. Endurance exercise in the severe, but not in the moderate exercise domain seems to challenge postural control requiring unimpaired sensory input. References Bencke R (2003). Methodological aspects of maximal lactate steady state-implications for performance testing. *Eur J Appl Physiol* 89, 95-99. Paillard T (2012) Effects of general and local fatigue on postural control: review. *Neurosci Biobehav Rev* 36, 162-176.

### OXIDATIVE STRESS AND RUNNING ECONOMY

Santos, J.M.B.1, Luna Jr, L.A.1, Foster, R.1, Estevam, V.1, Sá, M.1, Amirato, G.R.1, Pagani, L.G.1, Bachi, A.L.L.1,2, Vaisberg, M.1  
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Introduction Running economy is defined as the oxygen consumption necessary to run at a given determined speed and express the relation between energetic cost and work done. In a previous paper of our group we have demonstrated that less inflamed athletes showed increased running economy. It's well demonstrated that inflammation and oxidative stress are closely related. In this research we observed mechanisms of oxidative control during and soon after a marathon, and possible relation to running economy. Results Immediately after the race, levels of oxidized LDL (oxLDL) and total antioxidants complex (TAC) showed a significant decrease compared to baseline levels. Pearson's correlation analysis between running economy and TAC in the time 72 h after the marathon, that although not statistically significant ( $p=0.08$ ,  $r = 0.37$ ). Discussion This finding suggests that antioxidant molecules represented by TAC could buffer oxidative stress, preventing an increase of oxLDL. Seventy-two hours after the race, levels of oxLDL and TAC showed a tendency to return to the basal values. Conclusion The correlation between running economy and TAC suggests that athletes with lower values of running economy have greater necessity to use antioxidant mechanisms, in order to avoid a state of oxidative stress. References 1. LUNA JR, L. A. et al. Implicações do treinamento de força na economia de corrida de longa distância. *Terapia Manual*, v. 8, 2010 2. Bachi, A. L., Rios, F. J., Vaisberg, P. H., Martins, M., Cavalcante, D. S. M., Victorino, A. B., ... & Vaisberg, M. (2014). Neuro-Immuno-Endocrine Modulation in Marathon Runners. *Neuroimmunomodulation*. Contact: juliana-mbs@hotmail.com

### ACUTE PHYSIOLOGICAL DIFFERENCES BETWEEN CYCLING AND RUNNING AT MATCHED OXYGEN UPTAKES

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Introduction It is presumed that running compared to cycling exercise, promotes higher rates of oxygen uptake and energy expenditure in submaximal and maximal exercise intensities. Previous research was carried using one maximal protocol or a submaximal intensity to compare these exercise modes. The purpose of this study was to determine the differences in acute physiological responses of exercising in cycling and running at matched rates of oxygen uptake (from low-to-high intensities). Methods The sample comprised twenty voluntary male participants (age= $22.5 \pm 1.8$  years; height= $177.7 \pm 7.0$  cm; body mass= $72.6 \pm 7.9$  kg; fat mass= $7.87 \pm 1.3$  %) that performed five submaximal 8 min exercise bouts, interspersed with a 10 min period of passive recovery. Exercise intensity in the treadmill running was 10, 12, 14, 15 and 16 km/h (0% gradient), and in the cycle ergometer was 80, 120, 160, 180 and 200 W (65-70rpm). The following variables were measured using standardised protocols: oxygen uptake ( $\text{VO}_2$ ), ventilation, heart rate (HR), respiratory exchange ratio (RER), rate pressure product (RPP), blood glucose, systolic and diastolic blood pressure (SBP, DBP, respectively), body temperature (Temp), blood lactate and perceived exertion (RPE). To enable comparisons between the two exercise modes at matched oxygen uptakes, the results were forecasted for .5, 1, 2, 3, 4, 5 and 6 L/min of oxygen uptake, using intercepts and slopes obtained contrasting gathered data with their  $100 \cdot \text{LN}$ . The statistical comparisons between modes were carried via standardized mean differences and non-clinical magnitude-based inferences (Hopkins, Marshall, Batterham, & Hanin, 2009). Results The results obtained showed no differences between exercise modes in blood glucose, SBP, DBP, RER, RPP and Temp. Blood lactate, HR and RPE were significantly higher in cycling to forecasted oxygen uptakes above 4 L/min. Ventilation was higher in cycling for  $\text{VO}_2$  above 3 L/min. These differences ranged from moderate to high. Discussion Running or cycling at lower oxygen uptakes did not promote different acute physiological responses. However, at higher intensities the metabolic and perceptual acute responses were consistently higher, probably due to the lower muscle mass quantity and the cycling specific muscle contraction pattern. The blood lactate, HR and also RPE responses were likely dependent upon intensities near or above the anaerobic threshold. Exercise prescription should account for these dose-response mode effects, especially at higher intensities. References Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive Statistics for Studies in Sports Medicine and Exercise Science. *Medicine and Science in Sports and Exercise*, 41(1), 3-12.

### THE ASSOCIATION BETWEEN DAILY STEPS AND HEALTH: A Pedometer-Based, Cross-Sectional Study in an Employed South African Population

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Background: Walking is recognised as an easily accessible mode of physical activity and is therefore supported as a strategy to promote health and well-being. To complement walking, pedometers have been identified as a useful tool for monitoring ambulatory physical activity, typically measuring total steps/day. There is, however, little information concerning dose-response for health outcomes in relation to intensity or duration of sustained steps. We aimed to examine this relationship, among employed adults. Methods: A convenience

sample, recruited from work-site health risk screening (N=312, 37±9yrs), wore a pedometer for at least three consecutive days. Steps were classified as "aerobic" ( $\geq 100$  steps/minute and  $\geq 10$  consecutive minutes) or "non-aerobic" ( $< 100$  steps/minute and/or  $< 10$  consecutive minutes). The data were sub-grouped according to intensity-based categories i.e. "no aerobic activity", "low aerobic activity" (1-20 minutes/day of aerobic activity) and "high aerobic activity" ( $\geq 21$  minutes/day of aerobic activity), with the latter used as a proxy for current PA guidelines (150-minutes of moderate-intensity PA per week). Health outcomes included blood pressure, body mass index, percentage body fat, waist circumference, blood cholesterol and blood glucose. Analysis of covariance, adjusting for age, gender and total steps/day were used to compare groups according to volume and intensity-based steps categories. Results: Average steps/day were  $6,574 \pm 3,541$ ; total steps/day were inversely associated with most health outcomes in the expected direction ( $p < 0.05$ ). The "no aerobic activity" group was significantly different from the "low aerobic activity" and "high aerobic activity" in percentage body fat and diastolic blood pressure only ( $P < 0.05$ ). Conclusion: The study provides a presentation of cross-sectional pedometer data that relate to a combination of intensity and volume-based steps/day and its relationship to current guidelines. The integration of volume, intensity and duration of ambulatory physical activity in pedometer-based messages is of emerging relevance.

### ICYCLE MESSENGERS: ANTHROPOMETRIC CHARACTERISTIC AND PERFORMANCE

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**INTRO** Bicycle messengers are people who work for courier companies delivering items by bicycle. These Couriers are most often found in the central business districts of metropolitan areas. Courier companies use bike messengers because bicycle travel is less subject to unexpected holdups in city traffic jams, and is not deterred by parking limitations, fees or fines in high density development that can hinder or prevent delivery by motor vehicle, thereby offering a predictable delivery time. There are few studies which outlines the characteristics of this population. **METHODS:** This study analyzes the anthropometric and performance characteristics of 9 male bike messengers (30±6 years old). We took anthropometric measurements on each subject. These included height ( $1,75 \pm 0,02$ m), weight ( $67,6 \pm 4,3$ kg), body composition ( $15,2 \pm 2,3\%$  body fat), Body Mass Index ( $22 \pm 1,4$ ). An incremental VO<sub>2</sub>max Test ( $75 + 25$  W/min) has been performed by each subject. Ventilatory Threshold (VT) and relative power at this level have been calculated. Further measurements were collected during their working day using Cycleops Joule GPS® heart rate monitor in order to evaluate the metabolic cost of their working shift. **RESULTS:** Vo<sub>2</sub>max  $61,0 \pm 4,2$  ml/kg/min(-1) and Power Output at VT  $4,36 \pm 0,4$  W/Kg values were similar to those reported in literature for amateur cyclists. During an hour working shift, the average EE was  $361 \pm 92$  kcal/h; GPS-related data show an average of  $22,5 \pm 5,4$  kms, elevation gain of  $99,6 \pm 44,5$  m and speed of  $7,4 \pm 1,5$  km/h. **CONCLUSION:** Urban bicycle messengers are a workforce characterized by higher physiological values than standard workers'. Their EE is greater than other employees and, according to their vo<sub>2</sub>max, is strongly related to their body composition. Most of the time is spent in fat burning zones (below 65% of Vo<sub>2</sub>Max). Moreover, the heart rate pattern is highly variable during the shift, according to the type of delivery and urban track. Further investigations must be developed to unveil this new workers population. **REFERENCES** 1: Bernmark E, Wiktorin C, Svartengren M, Lewné M, Aberg S. Bicycle messengers: energy expenditure and exposure to air pollution. *Ergonomics*. 2006 Nov;49(14):1486-95. 2: Dennerlein JT, Meeker JD. Occupational injuries among Boston bicycle messengers. *Am J Ind Med*. 2002 Dec;42(6):519-25. 3: Achten J, Jeukendrup AE. Maximal fat oxidation during exercise in trained man, *Int J Sports Med* 2003; 24:603-608.

## Oral presentations

### OP-SH23 Sociology/Sport management

#### HUMAN RESOURCES IN GERMAN SPORTS ORGANIZATIONS: STRUCTURES, SYSTEMS, DEVELOPMENTS

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The associations and organizations of German organized sports are usually characterized – like all other non-profit-organizations – by voluntary work of their members. However, in times of increasing professionalization and commercialization of sport many tasks, obligations and responsibilities can't be covered only by volunteers anymore (Thiel, Meier & Cachay, 2006, p. 9). Already in 2012 one third of German sports associations and organizations had employed professional workers (cf. Breuer, 2013, p. 337). Especially in larger non-profit-organizations in German sports an increasing number of professional employees and a corresponding adjustment of their responsibilities and decision-making competences can be found. For a long-term understanding and explanation of these process changes, competence shifts etc., it is firstly necessary to collect empirically proved data of the current personnel structures and systems of the sports organizations to derive possible future developments. The German research community in sports science has dealt with the personnel in organized sports for a long time and from various analytical perspectives (cf. e.g. Winkler & Karhausen, 1985; Schütte, 1999; Cachay, Thiel & Meier, 2001; Wagner, 2008; Thiel & Meier, 2009). Scientific studies focusing exclusively on the professional employees, their current numbers, structures and systems on the highest level of sports organizations in Germany are lacking so far. For the exploration of this desideratum an empirical study with focus only on the professional staff in German sports organizations was carried out. Therefore, the German Olympic Sports Confederation (DOSB) and its 98 member organizations are questioned in a standardized online-survey in spring 2014. With a response rate of almost 72% the study provides, for the first time, meaningful results of the total number of employees of the sports organizations as well as the number of executives on the different hierarchy levels and their distribution of the separate working areas. Moreover, the data provides information about the processes of personnel recruitment and the implemented or planned measures of strategic human resources development. In addition to the presentation of the empirical study the lecture also contains a future-oriented view to the personnel development of organized sports in Germany. The change processes in the personnel structure as well as their reasons and consequences will be examined and scrutinized critically, inter alia, on the basis of the recent amendment of the DOSB (cf. Kosok, 2014; Kuske, 2014; Seubert, 2014; Deutscher Olympischer Sportbund, 2014).

## MONITORING AND EVALUATION AS STRATEGIC TOOL FOR PROGRAMME EFFECTIVENESS

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The absence of an overarching organizational and programme effectiveness theory impacts directly on the identification of success indicators for monitoring and evaluation purposes. Influential models of organizational and programme effectiveness in the sport sector underpin approaches of programme resourcing, processes and goal attainment from which indicators for monitoring and evaluation purposes could be identified and formulated. A synthesis of such theoretical approaches ensures that the various strengths and weaknesses of each not only complement the other in the management of the programme, but also inform indicator identification as well as the process for monitoring and evaluation. The internationally developed and advocated Nike Designed to Move Framework for Action identified seven distinguishable filters (indicators) that focuses on input, process and output that are not only provided for programme design, management and delivery, but also for monitoring and evaluation purposes. The aim of the study was to monitor and evaluate the programme management and delivery of the Butterflies programme in Alexandra Township in the Greater Johannesburg against the seven filters or indicators as proposed by the Designed to Move Framework developed by Nike. A Participatory Action Research (PAR) approach was followed utilizing the S.DIAT (Sport in Development Impact Assessment Tool), with a pre- post design. Mixed methods allowed for quantitative and qualitative data capturing which comprised of attendance and activity registers completed by coaches, questionnaires completed by coaches and primary school participants, interviews with school representatives and focus groups with coaches and participants. Observations of facilities and practice sessions were also made during the research visits. Findings show that the learners' attendance of training sessions was relatively high with a low average dropout rate. Relatively more girls than boys attended the programme across the schools with an age spread of between 8 and 13 years of which most being between the ages of 8 and 10 years. Narratives demonstrate a high level of fun from all participants, with an observed change from 'wanting to compete' or 'develop talent' to 'having fun' and 'playing with friends' over time. In addition most participants were highly satisfied with the quality of sessions, although boys expressed a need for 'more technical knowledge'.

## PUBLIC VIEWING EVENT VISITORS AND THEIR CONTRIBUTION TO ECONOMIC AND TOURISM IMPACT – EVIDENCE FROM BERLIN DURING THE WORLD CUP 2014 IN BRAZIL

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**Introduction** The analysis of the economic impact of sporting mega-events is always a very controversial debate amongst economists. Hosting events can cause positive effects regarding tourism and economic impacts. The demand from tourists can subsidize the production of goods and services, by the advantages of economics of scale. Events are considered as an important tool for the destination marketing (event signaling). This study analyzes the economic and tourism impact of sport events, paying special attention to a relatively new phenomenon, public viewing events, which take part away from the hosting cities of the real sporting event. Therefore, the aim of the study was to identify event legacies for Berlin caused by event visitor's expenditures. Theoretical roots to ascertain consumption patterns draw back to the study from Preuss, Kurscheidt and Schuette (2009), Preuss (2007) and Gratton, Dobson and Shibli (2000). Methods Data was conducted with a questionnaire. The survey was conducted personally and consists of 150 variables collected at public viewing events in Berlin (n = 880). The research design was based on the very similar surveys done at the FIFA World Cup 2006 and 2010. The analysis of data based on total consumption of the event visitors and the released economic effects to the city of Berlin. Results The presentation will focus on the public viewing visitor's consumption at public viewing events in Berlin during the FIFA World Cup 2014. It will show the visitor's consumption as a significant contribution to the economic success for the city of Berlin. Furthermore, the study gives an overview about the most important socio-demographic data of public viewing event visitors. Finally the presentation shows overall economic impact of public viewing events 2014 caused by its visitors. Discussion It is fact, that different events have different effects for the host cities (Kurscheidt, 2009; Hall, 1992). It will become clear, that all events has different visitors consuming different as well as that is not possible to predict event-legacies without any information on the consumption and other data of visitors. Therefore, a prediction of any economic impact for future events should be done with great care. References Gratton, C., Dobson, N. & Shibli, S. (2000). The Economic Importance of Major Sports Events: A Case Study of Six Events. *Managing Leisure*, 5 (1), 17-28. Hall, C. M. (1992). *Hallmark Tourist Events: Impacts, Management and Planning*. London: Belhaven Press. Kurscheidt, M. (2009). The World Cup. In W. Andreff & S. Szymanski (Eds.), *Handbook on the Economics of Sport* (pp. 197-213). Cheltenham: Edward Elgar. Preuss, H. (2007). The Conceptualisation and Measurement of Mega Sport Event Legacies. *Journal of Sport & Tourism*, 12 (4), 207-228. Preuss, H., Kurscheidt, M. & Schuette, N. (2009). *Ökonomie des Tourismus durch Sportgrossveranstaltungen: Eine empirische Analyse zur Fußball-Weltmeisterschaft 2006*. Wiesbaden: Gabler.

## THE ONLINE MARKETING TOOLS USED BY HUNGARIAN FIRST DIVISION FOOTBALL CLUBS

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**Introduction** We often here the phrase, that if you, your institution, your firm, your product etc. is not "on the internet" that it does not exist. This sentence is really hard to den in a world where the average internet penetration in Europe is over 70%, and a community called Facebook has over 890 million active daily users – and the number of monthly users exceeds 1, 39 billion – and where 280 million people send over 500 million tweets daily. Sport teams in Hungary still barely use online marketing tools. Since the teams' main income source is from government funding – i.e. through the income tax regulation system – the teams are not forced to use similar marketing tools as in other countries which also stands for online marketing tools as well. Current study investigates the online marketing tools used by Football teams playing in the Hungarian 1st Division (N=16). While the two main online marketing tools used by Hungarian sport teams and individuals are websites and Facebook pages, we intend to concentrate the content of these two marketing communication tools. Other online tools will be taken into consideration if this pilot study shows their significance. Research Questions RQ1: What types of online marketing tools 1st Division Football clubs use in General? RQ2: What types of communication tools (e.g., status update, video, links) are most frequently used on the teams' website? RQ3: How often the team shares information through its website and their Facebook site. RQ4: What types of communication tools (e.g., status update, video, link) are most frequently used on their website and Facebook site? RQ5: What types of information the 1st Division Football clubs shares on their website? RQ6: What types of information the 1st Division Football clubs shares on their Facebook page? RQ7: What are the factors differentiates the clubs from each other (city size, number of followers, region inside the country, other demographic factors) RQ8: How the followers of the teams Facebook page responds to differ-

ent types of contents? Methodology For answering RQ1, we search through the website of each clubs looking for links to other online marketing tools. In the cases of RQ2 to RQ8 we use content analysis methods. The coding of the categories and variables will done later in accordance of the content of the. The website and Facebook page will be followed for two consecutive weeks in March (the start of the spring season) and May. Expected Results While our research is just in the preparatory phase, we can just assume the predicted future results. We predict, that Football teams playing in the Hungarian 1st Division are not using online marketing tools as frequent and as effective as other western or eastern European teams playing in the similar Division of their country. Also the frequency and the following of the information will be lower as well. We believe that this is because of the governmental funding and the lack knowledge in online marketing.

### EFFECTIVENESS OF PROFESSIONAL HANDBALL CLUBS

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Introduction In European handball most of the professional handball clubs are still operating as non-profit sport organization, however, they have a lot of profit-orientated issue as well. Today sports organizations are becoming more business-like (Gammelsæter, 2010) hence it is really important for the handball clubs to adapt to the more professional and commercialized sports world. Stakeholders and other agencies have interest in doing business within sports clubs (Smart, 2007), thus it is essential how sport results are realized besides different institutional logics, economic and organizational efficiency affected by commercialization. Different European professional handball clubs are influenced by globalization and commercialization in a different way. Even if clubs are non-profit sports organizations or operated by different kind of companies they may have mixed funding, operating system, and still not commercialized completely. "Commercial" is frequently translated as "for-profit" or "concerned with making money" (Westerbeek & Smith, 2003), but beside the background of frequent overspending and low profitability of European commercialized sport clubs, they are more likely moving from non-profit to "not-profit" form than to for-profit (Gammelsæter, 2010). The aim of this paper is to give a descriptive analyzes of globalization's and commercialization's effects on professional handball club management, organizational performance in Denmark, Hungary and Sweden, three powerhouses in European handball, in addition to determine the factors of high-level professional handball clubs' effectiveness (by cultural, organizational context; by professional and economic results). Methods The used methods were qualitative and quantitative to analyse the aspect of handball clubs and leagues. On the one hand in-depths interviews of the qualitative perspective were important to understand processes of the clubs and to describe the handball clubs' culture in question. On the other hand we used Data Envelopment Analysis (DEA) in order to define frontier efficiency in the selected countries, in addition to define the most efficient and interesting clubs for further selection and measurement. Results Essential difference were found between the clubs' efficiency, in addition similarities were found between the handball clubs' culture and institutional logics in the selected countries. References Gammelsæter, H. (2010) Institutional Pluralism and Governance in "Commercialized" Sport Clubs. *European Sport Management Quarterly*, Vol. 10, no. 5. Smart, B. (2007) Not playing around: global capitalism, modern sport and consumer culture. *Global Networks*, Vol. 7: 113–134. Westerbeek, H., & Smith, A. (2003) Sport business in the global marketplace. p. 89. New York: Palgrave Macmillan. Contact kinga.barath@hotmail.com

## Oral presentations

### OP-SH16 Physical Education & Pedagogics II

#### HUMAN PRACTISING IN PHYSICAL EDUCATION

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'Learning and knowing' is a prominent theme in research on the school subject physical education (PE). In Sweden, this research goes hand in hand with debates around what learning and knowing could be about both in PE (Nyberg & Larsson, 2014; Quennerstedt & Larsson, 2015) and in PE teacher education (Backman & Larsson, 2014). In an attempt to broaden the scope concerning learning and knowing in PE practice, I will explore an alternative approach to the theme, namely human practising. My ambition is to outline the concept of practising (in Swedish: övning, att öva) as an analytical tool for exploring learning and knowing in PE. My overarching aim is hopefully to contribute to the discussion about the aim of PE in schools, what students are to learn (or know), i.e. what they might be practising during PE practice. In his book *You must change your life!*, German philosopher Peter Sloterdijk maintains that human beings are practising animals (Sloterdijk, 2013). In fact, "humans are beings that cannot not practise" (Sloterdijk, 2013, p. 407). Practising should not be confused with merely doing an activity or training a specific capacity of the organism. Rather, it means "any operation that provides or improves the actor's qualification for the next performance of the same operation, whether it is declared as practise or not" (Sloterdijk, 2013, p. 4). In short, human practising involves agency, effort, repetition and vertical tension between better or worse. Further, it always has a background, involves apprenticeship and is related to self-perfection. Even if practising appears to be a most obvious and basic aspect of human movement (humans need to practise even the most basic things such as standing, walking, running, etc.), it has hardly received any attention in the philosophy of sport and accounts of human activity in general. There can be many reasons for this. One could be that the precise nouns and verbs that describe this phenomenon in German (Übung/üben) and Scandinavian languages (öva, övning) easily lose their meaning when translated into the English noun practice or verb practise. This may have confused the active human activity of 'being practising' with merely taking part in social practices. In the presentation, I will use the concept human practising as outlined above in an analysis of some video excerpts from a previous project called "Physical education and health – a subject for learning?" Backman, E. & Larsson, H. (2014) What should a Physical Education teacher know? *Physical Education and Sport Pedagogy*. iFirst. DOI: 10.1080/17408989.2014.946007. Nyberg, G & Larsson, H. (2014) Exploring 'what' to learn in physical education. *Physical Education and Sport Pedagogy*, 19(2), 123-135. Quennerstedt, M. & Larsson, H. (to appear in 2015) Learning movement cultures in Physical Education practice. Editorial. *Sport, Education and Society*. Sloterdijk, P. (2013) *You must change your life. On anthropotechnics*. Cambridge: Polity Press.

## INCLUSION WITHIN SWEDISH PHYSICAL EDUCATION? PROBLEMATIZING THE 'TEXT' SURROUNDING PHYSICAL EDUCATION AND THE EXPERIENCES OF IMMIGRANT YOUTH

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Introduction: Sweden has a relatively long history of immigration, despite recent local media rhetoric that would assume otherwise. Interestingly, Swedish government based data suggests that young people from an 'immigrant' background are less likely to be represented among the top 'scoring' students within physical education, and more likely to be over-represented among the lower 'scoring' students. Whilst such data can be problematic and reductive in nature, it also raises important questions surrounding the implementation of democratic practices within physical education in Sweden, which self identifies as a country that has a long and established history of inclusiveness and equality across all sectors of society. Aim: The aim of this presentation is to look beyond government-based statistics and to problematize the 'text', based on policy documents and academic literature within physical education and the experiences of immigrant youth surrounding physical education practice, with a focus on the Swedish context. Methodology: Postcolonialism provides a useful framework to 'borrow' from, through which to consider how Eurocentric ways of knowing have shaped the historical developments, curriculum documents and current (dominant) pedagogical practices within physical education. This will allow us to problematize the physical education experiences of immigrant youth as presented through government statistics. Discussion and Conclusion: While research has shown that Swedish curriculum has a strong focus on movement and physical activity participation, and that it is less competitive and performance based when compared to other countries, there still remains a discrepancy between policy and practice. Swedish based research continues to highlight a tendency for 'masculine' (and we would add 'western') ball based team sports to dominate physical education lessons. Furthermore, while the physical education experiences of young immigrants is considered within contemporary research, a dearth of literature remains that actually explores the meaning and place of physical activity and physical education in the lives of young immigrants, from the young people themselves. In a country that strives for equality across society, gender perspectives continue to dominate, and while important, it must be acknowledged that not all 'males' and 'females' experience their gender in the same way. It is through exploring and questioning dominant practices within physical education that allow for a more complex understanding of the experiences of young immigrants in physical education. This line of questioning opens up spaces for new possibilities and avenues through which to move towards a more sustainable democratic physical education for the future.

## DEVELOPMENT OF QUALITY PHYSICAL EDUCATION IN ASIAN SCHOOL – PERCEPTION AND ACHIEVEMENT

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Do not insert authors here Introduction The conference of UNESCO on the twenty-first of November 1978 in Paris adopted the International Charter on Physical Education with the purpose to place the teaching of physical education in school as the service of human progress due to its intrinsic value in education, social life and health development. Governments, competent non-governmental organizations, educators, families and individuals were urged to disseminate it and to put it into practice. It was almost thirty-five years after the implementation of the Charter and physical education experienced the gradual transformation from sport as a recreation into a formal subject in learning. For many countries, physical education is already the norm for practice in school education with equal academic status like the study of language, science, mathematics, arts, health and social studies. This specific nature yielded the interest to investigate its current status and conditions of work when there is a trend to call for quality improvement for education in school (Hardman, 2008, 2013). Methods This paper shared the research work on Quality Physical Education from 2011 to 2013. 10 Asian cities coming from High, Upper Middle and Lower Middle Income Groups were involved in the survey. Questionnaires were sent to physical education and sport professional with request to answer questions on three perspectives of "status and role of physical education", "educational elements" and "development of supportive features" and a return of N=782 were collected. Descriptive statistics, table means, pairwise mean comparison between cities and Post-Hoc Scheefe's test were used to present the observation. Results Data indicated a consistent pattern of high agreement on status and role, educational elements and supportive features but exhibited with cautious when questions were asked on the achievement of educational elements and supportive features. Regarding to the general trend of development for physical education, Lower Middle Income Group did not indicate "poor" performance when compared with the High and Upper Middle Income Groups. Discussion There is a common agreement on the provision of physical education in school. This common agreement seems to be universal and serves as fundamental principles in the improving works of physical education. Yet, it is essential to recognize the fact that quality support and educational development for physical education are necessary but not pre-requisite criteria for success. References UNESCO 1978, UNESCO, UN. Hardman K 2008 Kinesiology, vol. 40, no. 1, pp. 5-28. Hardman K 2013, International Journal of Physical Education, vol. L, no. 3, pp. 15-28.

## STUDENTS' MOTIVATION TOWARDS PHYSICAL EDUCATION: INDIVIDUAL, CLASS-LEVEL AND TEACHER-LEVEL FACTORS

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Introduction As autonomous motivation (Deci & Ryan, 2000) leads to positive outcomes (Haerens et al., 2010), the main aim of this paper is to investigate the relationships between teacher-level factors, class-level factors and individual characteristics and students' motivation for PE. Methods Participants of this quantitative research were 1156 Flemish secondary school students. To define the type of motivation, the students filled in the BRPEQC (Aelterman et al, 2012). Teacher behaviour was measured by the TASCQ; individual and class-related factors were also measured through questionnaires. Results/Findings Individual factors explain most of the variance as well for autonomous motivation (86,21%), controlled motivation (93,65%) as for amotivation (92,97%). On the individual level, girls ( $\beta = -0.611$ ) and older teenagers ( $\beta = -0.082$ ) are less autonomous motivated. On the class level, pupils from vocational schools ( $\beta = 0.236$ ) are more amotivated, as well as pupils who emphasize the importance of the infrastructure ( $\beta = 0.062$ ), the topic ( $\beta = 0.117$ ) and the atmosphere in the class ( $\beta = 0.066$ ). On the teacher-level, pupil who perceive need support ( $\beta = 0.594$ ) are more autonomous motivated. Conclusion Differences in motivation towards physical education between students are more exhaustive than differences between classes or teachers. The importance of considering individual, class-level and teacher-level factors when explaining variance in motivation for PE is clearly exposed. This can give important guidelines to teachers and authorities. Discussion The importance of considering individual, class-level and teacher-level factors when explaining variance in motivation for PE is clearly exposed. Anyhow, we need to emphasize that these results

do not explain causalities or outcomes towards motivation. Contact lise.speleers@hogent.be

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## INCLUSIVE PHYSICAL EDUCATION, WITH A FOCUS ON AUTONOMY, COMPETENCE AND RELATEDNESS

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In Denmark, a considerable percentage of children, e.g. girls with a migrant background, do not participate in physical activities, PA and are marginalized in physical education, PE lessons. Evaluation of PE in Danish schools shows that the causes of the pupils demotivation are lack of study plan, lack of participation and too much focus on competitive sports (Danmarks Evalueringsinstitut 2004, Von Seelen 2012). A school reform is currently being implemented in Denmark. The intention is to improve inclusive education and to enhance the academic standards for all pupils in the public schools. This study investigates girls' motivation for physical education. On the basis of the empirical findings, our study suggests a didactics, which enhances the pupils' activity rates and improve their participation in PE. The data analysis is inspired by Self Determination Theory, which is a motivational theory, containing three main categories: autonomy, competence and relatedness. Methods: The study focuses on the 6th and 7th grade and specifically on girls. The data consist of observations in 8 classes at two schools in socio-economic underprivileged areas and two schools in socio-economic privileged areas and focus group interviews, combined with in-depth interviews with 16 selected girls before and after a 7 weeks intervention in so called Inclusive PE. Results: The findings showed that the three categories from the Self Determination Theory are suitable for investigating motivation for PE. Significant in the study was the girls' feeling of the boys' dominance in PE in the ordinary PE lessons also in a Danish context. The interventions in inclusive PE in the classes focusing on 'autonomy', 'competence' and 'relatedness', showed that it increased the girls' motivation for PE, especially in the classes where the girls had a good relationship with the teacher. Furthermore, it was clear that the girls felt best in an environment characterized by helpfulness, cooperation and work in smaller groups. In the interviews, the girls pointed out the importance of knowing the goals of the teaching, variation in the activities and achieving specific skills. Discussion: A review of studies in PE using SDT conclude that it is not the content that matters for the children's feeling of motivation but the methods used and the teachers' way of giving response to the pupils (Berghe 2014). The present study reaches the same conclusion, but goes further in the suggestion of an inclusive didactics in PE focusing on all three categories in SDT. References Berghe, L. V. D., et al. (2014): Research on self-determination in physical education: key findings and proposals for future research. *Physical Education & Sport Pedagogy*. Vol. 19 Issue 1, p97-121. Danmarks Evalueringsinstitut (2004): Idræt i folkeskolen – Et fag med bevægelse. Von Seelen, J. (2012) Læring, praksis og kvalitet i idrætstimerne. Institut for Idræt og Biomekanik, Syddansk Universitet, Ph.d. afhandling. soro@phmetropol.dk

## FORMATION PROCESS OF STUDENTS' PERCEPTIONS OF PHYSICAL EDUCATION

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Introduction The basic goal of all health and physical education courses is to develop cognitive and social skills relative to the body and the overall self. Therefore, in designing such a class, great importance needs to be placed on teaching material selection and unit sequence. Furthermore, students' perceptions of such classes have gradually been recognized as important. The present study analyzes the processes by which students form such perceptions. Methods Subjects were freshmen (N = 126) enrolled in a university general physical education course. The course unit order was arranged thus: badminton, volleyball, and basketball. We asked the subjects to record simple notes after every class. At the end of the course, the students were allowed to refer to these notes to describe their thoughts, which were broken down into four categories: one per course unit and one labeled "throughout the whole course." We analyzed the documented responses via text mining. First, we examined the 20 most frequent words and identified 11 common to all four sections. Second, from a physical education perspective, we created eight codes similar to the most common words: 'educational materials,' 'collective cohesion,' 'play skill,' 'game,' 'interaction,' 'others,' 'self,' and 'positive emotion.' Third, we compared the frequency of codes across sections. Data were analyzed through cross tabulation and chi-squared tests. Results The frequency of 'education materials' ( $\chi^2 = 37.6$ ,  $p < .001$ ), 'collective cohesion' ( $\chi^2 = 18.7$ ,  $p < .001$ ), 'play skill' ( $\chi^2 = 6.5$ ,  $p < .005$ ), 'interaction' ( $\chi^2 = 11.6$ ,  $p < .001$ ), and 'others' ( $\chi^2 = 7.1$ ,  $p < .001$ ) significantly differed between the badminton and volleyball sections. The frequency of 'education materials' ( $\chi^2 = 32.0$ ,  $p < .001$ ), 'collective cohesion' ( $\chi^2 = 10.0$ ,  $p < .001$ ), 'play skill' ( $\chi^2 = 25.4$ ,  $p < .001$ ) differed between the badminton and basketball sections. The frequency of 'play skill' ( $\chi^2 = 5.9$ ,  $p < .005$ ), 'interaction' ( $\chi^2 = 15.4$ ,  $p < .001$ ), 'others' ( $\chi^2 = 5.8$ ,  $p < .005$ ) significantly differed between the volleyball and basketball sections. Discussion Eleven common elements were found between the segments that represented the students' reflection processes. For the volleyball course especially, enhanced team interactions had a significant effect on collective cohesion. Interaction was shown to be the foundation for effective play skill development. The 'positive emotion' identified in the overall evaluation of the course appeared to be in response to the unfolding of the overall teaching process. References Gallagher, J. (1994). Teaching and learning: New models. *Annual Review of Psychology*, 45,171-195. [nakazawa@u-aizu.ac.jp]

## Oral presentations

### OP-PM22 Physiology: Vascular biology

#### IMPROVED CAPILLARY ULTRASTRUCTURE AFTER EXERCISE TRAINING IN PATIENTS WITH ESSENTIAL HYPERTENSION

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1: NEXS (University of Copenhagen, Denmark), 2: Institute of Anatomy (University of Bern, Switzerland), 3: CMRC (Copenhagen, Denmark), 4: Department of Cardiovascular and Renal Research (University of Southern Denmark, Denmark) Introduction Essential hypertension is a major cardiovascular risk factor affecting approximately 1 billion people worldwide. The pathogenesis of essential hypertension is multifactorial and includes capillary rarefaction in various tissues, which may ultimately limit tissue oxygenation. However, little is known about skeletal muscle capillarization and capillary ultrastructure in essential hypertension and how this is affected by exercise training in man. Methods To investigate skeletal muscle angiogenesis and capillary ultrastructure in essential hypertension, muscle biopsies were obtained from m. vastus lateralis in essential hypertensive patients ( $183 \pm 7/101 \pm 5$  mmHg;  $n=10$ ) and normotensive controls ( $142 \pm 5/74 \pm 3$  mmHg;  $n=11$ ) before and after 8 weeks of aerobic exercise training. Morphometry was performed after transmission electron microscopy and protein levels of several angioregulatory factors were determined. Results At baseline, capillary density and capillary-fiber-ratio were not different between the two groups. However, hypertensive patients had 9% lower capillary area ( $12.7 \pm 0.4$  vs.  $13.9 \pm 0.2 \mu\text{m}^2$ ) and tended to have thicker capillary basement membranes ( $399 \pm 16$  vs.  $358 \pm 13$  nm;  $P=0.094$ ) than controls. Protein expression of vascular endothelial growth factor (VEGF), VEGF receptor-2 and thrombospondin-1 were similar in normo- and hypertensive subjects but tissue inhibitor of matrix metalloproteinase was 69% lower in the hypertensive group. After training, angiogenesis was evident by 15% increased capillary-to-fiber ratio in the hypertensive patients only. Capillary area and capillary lumen area were increased by 7% and 15% in the hypertensive patients whereas capillary basement membrane thickness was decreased by 17%. VEGF expression after training was increased in both groups whereas VEGF receptor-2 was decreased by 25% in the hypertensive patients. Discussion Essential hypertension is associated with decreased lumen area and a tendency for increased basement membrane thickening in capillaries of skeletal muscle. Exercise training appears to improve the diffusion conditions in essential hypertension by altering capillary structure as well as capillary number. These data adds to the understanding of the pathogenesis of essential hypertension at the microvascular level and suggest that, in pathological conditions where capillary ultrastructure is affected, exercise training could be a novel therapeutic intervention for normalizing capillary morphology in hypertension. Contact gliemann@nexs.ku.dk

#### RESPONSES TO AN ISOMETRIC LEG-EXERCISE TEST PREDICTS SEX-SPECIFIC TRAINING-INDUCED REDUCTIONS IN RESTING BLOOD PRESSURE AFTER ISOMETRIC LEG TRAINING

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Introduction Isometric training, using either isometric handgrip (IHG) or isometric bilateral-leg (IBL) protocols, is an effective method of lowering resting systolic blood pressure (SBPrest). However, the reductions in SBPrest seen after training vary widely between individuals. Predicting likely training-induced reductions in SBPrest could make it possible to optimise the effects of the training in all participants. It is known that post-IHG training reductions in SBPrest can be predicted by SBP responses to a 2 minute IHG task in both hypertensive and older normotensives (Millar et al., 2009; Badrov et al., 2013). However, the predictability of such a test in younger individuals and when using a comparable IBL task, has not been established. Furthermore, it is not known whether these simple isometric tests can predict reductions in ambulatory SBP (mean 24-hour, SBPamb) as well as SBPrest. Therefore, the purpose of this study was to determine whether an IBL test can be used to predict training-induced reductions in SBPrest and SBPamb following 10 weeks of IBL training in young men and women. Methods Resting and ambulatory BP (SBPrest and SBPamb) were measured prior to and following 10 weeks of IBL training using an isokinetic dynamometer (4, 2-minute contractions at 20% MVC with 2 minute rest periods, 3/week) in 20 normotensive individuals (10 men, age= $21 \pm 4$  years; 10 women, age= $23 \pm 5$  years). SBP responses to the IBL test (single 2-minute period of IBL exercise) was derived by calculating the difference between peak SBP and mean baseline SBPrest. Pearson's product moment correlation coefficient was used to assess the relationship between the blood pressure responses to a short 2-minute IBL test and the magnitude of the reductions in SBPrest and SBPamb after IBL training. Results There were significant reductions in men and women's SBPrest ( $7.0 \pm 4.8$  mmHg,  $p=0.0001$  &  $5.7 \pm 4.1$  mmHg,  $p=0.001$ ) and SBPamb ( $4.0 \pm 1.9$  mmHg,  $p=0.011$  &  $6.1 \pm 4.1$  mmHg,  $p=0.0001$ ) following training. These changes in SBPrest were strongly correlated with pre-training SBP response to the IBL test in both men ( $r=-0.83$ ,  $p=0.003$ ,  $SEE=3.03$ ) and women ( $r=-0.81$ ,  $p=0.004$ ,  $SEE=2.56$ ). However, the magnitude of the reductions in SBPamb were not correlated with SBP response to the IBL test (men,  $r=-0.44$ ,  $p=0.199$ ,  $SEE=1.76$ ; women,  $r=-0.23$ ,  $p=0.517$ ,  $SEE=6.01$ ). Discussion These results support previous research which has identified that IBL training is an effective tool for lowering both resting and ambulatory BP. Furthermore, a simple isometric exercise test can be used as a tool to predict reductions in resting SBP, but not ambulatory SBP, after IBL training in both men and women. This test could be used to optimise the effects of this type of training in a wider range of participants, perhaps through modification of the training, to suit the anticipated effects in different individuals. Badrov BM, Horton S, Millar PJ, McGowan CL. (2013). *Psychophysiol.* 50(4), 407-414 Millar PJ, Bray SR, MacDonald MJ, McCartney N. (2009). *Blood Press Monitoring.* 14, 190-195

#### THE MECHANISM OF EXERCISE LIMITATION IN ILIOFEMORAL VEIN OBSTRUCTION POST-DVT

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Hypothesis and Aim: In a previous study, we showed that iliofemoral Vein Obstruction after deep vein thrombosis (DVT) resulted in reduced lower limb exercise capacity. In this study, we investigated the mechanism involved in reduced exercise capacity in post-DVT patients. Methods: Upper and lower exercise capacity were assessed by bimodality incremental symptom-limited cardiopulmonary exercise testing using leg or arm cycle ergometers. Subjects were 7 post-DVT patients with residual iliofemoral vein obstruction; controls

were 8 healthy volunteers. Leg vein obstruction was modelled by application of cuff tourniquets, inflated to 30mmHg, to the thighs of healthy controls. Results were median (range). Results: The ratio between upper and lower limb  $\dot{V}O_2$  peak was elevated in the post-DVT group, 1.14 (0.77-1.43) versus 0.71 (0.60-1.00) in controls ( $p < 0.003$ ), indicating that in post-DVT lower body exercise capacity is reduced while upper body exercise capacity is preserved.  $\dot{V}CO_2/WR$  slope was higher in the healthy group - median 13.6 ml/watt/min (range: 12.9-16.3) than in the post-DVT group - median 12 ml/watt/min (range: 7.1-15.5) ( $p = 0.029$ ), with no difference in  $\dot{V}O_2/WR$  slope. In controls, bilateral leg vein obstruction by application of tourniquets reduced peak  $\dot{V}O_2$  in leg exercise to 73% predicted (55-106%) vs 89% (77-130%) in the standard test,  $p < 0.05$ .  $\dot{V}CO_2/WR$  slope was higher in the standard test -13.6 ml/watt/min (range: 12.9-16.3) than the 2-tourniquet test - median 12.1 (range: 10.9-14.7),  $p = 0.036$ . The decrease of  $\dot{V}CO_2$  from peak exercise to 1' recovery was faster in the standard test - median 847 ml/min (range: 570-1479) compared to 680 (147-909) in the two tourniquet test ( $p < 0.025$ ) Conclusions: The comparison of exercise capacity in arm versus leg exercise suggests that reduced exercise capacity in post-DVT patients with venous obstruction may be caused by reduced venous return to the heart due to venous pooling. In post-DVT patients and in the experimental venous obstruction (thigh tourniquet) healthy control group, the slower  $\dot{V}CO_2$  kinetic in recovery and the reduced  $\dot{V}CO_2/WR$  slope may suggest a sluggish removal of  $CO_2$  from exercise muscle. This may result in an increase in localized acidosis in the muscles that may contribute to exercise limitation in post-DVT patients. These mechanisms may contribute to the pathophysiology of the reduced exercise capacity in post-DVT patients with venous obstruction.

### **BREAKING UP PROLONGED SITTING TIME WITH LIGHT INTENSITY PHYSICAL ACTIVITY BREAKS DOES NOT IMPACT BRACHIAL ARTERY ENDOTHELIAL FUNCTION**

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Background: Prolonged periods of uninterrupted sitting cause an acute reduction in endothelial function [1]. Similarly, endothelial function is reduced following ingestion of a high fat meal (HFM) [2]. The cumulative effects of these behaviours is such that a significant proportion of life may be spent in a state of endothelial impairment. Recent evidence suggests regular light intensity physical activity (LPA) can offset the decline in endothelial function associated with prolonged sitting, however the effects of LPA breaks on postprandial sitting is unknown. The aim of the current study was to investigate the impact of regular LPA breaks from sitting on endothelial function, following ingestion of a HFM. Study Design and methods: Fifteen young, healthy males (21±1yrs, BMI 24±3 kg/m<sup>2</sup>) participated in a three-trial repeated measures experiment. In each trial participants ingested a HFM (1000kcal, 52g fat), followed by 30 minutes of seated rest. Participants then undertook, in a randomised order on different days, 4 hours of: continuous sitting; continuous standing; or sitting with 2-min bout of self-selected, light intensity treadmill walking (5.1±0.4 km•h<sup>-1</sup>) every 30-min. Brachial artery endothelial function was assessed via flow mediated dilation (FMD) prior to HFM (PRE), 30-min after consumption of HFM (POST1), after completion of 2-hrs of the trial (POST2hr), and on completion of the 4 hour trial (POST4hr). Data were analysed using mixed linear modelling and are presented as mean±SD. Results: There was no change in FMD over time (PRE: 7.36±0.91%, POST1: 7.73±0.69%, POST2hr: 6.99±0.24%, POST4hr: 7.02±0.64%,  $P = 0.338$ ), or in response to the trials ( $P = 0.240$ ). Furthermore no interaction between condition and time were evident for FMD ( $P = 0.379$ ). Discussion: A period of 4 hours continuous sitting, following a HFM had no effect on brachial artery endothelial function in young, healthy males. Interrupting post prandial continuous sitting with regular, light activity breaks had no additional effects on brachial artery endothelial function. Recent findings [1] indicate that femoral artery FMD is attenuated after acute, prolonged sitting, our data implies that these negative vascular effects may not be present systemically. 1. Thosar, S.S., et al., Effect of Prolonged Sitting and Breaks in Sitting Time on Endothelial Function. *Med Sci Sports Exerc*, 2014. 2. Gill, J.M., et al., Effects of prior moderate exercise on postprandial metabolism and vascular function in lean and centrally obese men. *J Am Coll Cardiol*, 2004. 44(12): p. 2375-82.

### **EFFECT OF INFLAMMATION AND VITAMIN D ON HANDGRIP STRENGTH IN NON-INSTITUTIONALIZED OLDER ADULTS.**

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Introduction: Inflammation has been suggested to affect skeletal muscle metabolism and low levels of 25-hydroxyvitamin D (25(OH)D) are commonly associated with impaired muscle strength. We investigated the associations of high-sensitivity C-reactive protein (hs-CRP), as an indicator of acute inflammation, and serum 25(OH)D levels with maximal isometric handgrip strength, in non-institutionalized older adults. Methods: Study conducted among a sub-sample of 91 non-institutionalized older adults (77% female; aged 70-94 years), randomly recruited from a total sample of 1338 subjects from Viana do Castelo region, north of Portugal. Handgrip strength was measured using a hydraulic hand dynamometer (SH5001, SAEHAN Corporation), according to the American Society of Hand Therapists (Fess EE., 1992). Hs-CRP was measured with immunoturbidimetric assay and 25(OH)D serum levels were determined by immunochemiluminescent assay in the end of the summer season (October-November 2014). Generalized linear models were used to analyse the independent associations of hs-CRP and 25(OH)D, with handgrip muscle strength (Kg). Results: After adjustment for age, gender and BMI, high hs-CRP was an independent predictor of lower levels of grip strength (right hand:  $\beta$  (95%CI)=-0.31 (-0.55; -0.07); left hand (95%CI):  $\beta$ =-0.30 (-0.53; -0.07)). In the opposite way, 25(OH)D levels were positively associated with higher levels of muscle strength (right hand:  $\beta$ (95%CI)=0.16 (0.06-0.10); left hand:  $\beta$  (95%CI)= 0.15 (0.06-0.25)). Additionally, we found a high prevalence of vitamin D deficiency and insufficiency (78% deficient: <20ng/ml; 96% insufficient: <30ng/ml), although samples were obtained in the end of the summer season. Conclusions: Our data demonstrate the independent association between inflammation and handgrip strength in non-institutionalized older adults. If not corrected, reduced strength may have implications in the functional status, morbidity and mortality risk. Also, the high prevalence of vitamin D insufficiency and deficiency, even in the post-summer season, and its associations with poor muscle strength, suggests the need to implement strategies to normalize vitamin D levels among these individuals. Acknowledgments: This study was supported by Fundação para a Ciência e a Tecnologia [Ref.: PTDC/DTP-DES/0209/2012].



## Oral presentations

### OP-PM41 Training & Testing: Strength II

#### EFFECTS OF BODY POSITION ON FORCE EXERTED DURING SUSPENSION TRAINING

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Introduction Suspension training (ST) has become a popular form of bodyweight resistance training, eliciting higher muscle activations with respect to traditional exercises due to muscle activity used to maintain body stability and balance (McGill et al 2014; Snarr et al 2014). The load applied on upper and lower body can be modified by moving the center of mass outside of the base of support by changes in straps length and/or feet placement. Therefore, the aim of this study is to evaluate the effects of different body positions on force exerted on upper and lower body during a static push-up position performed on a ST device. Methods After giving his informed consent of participation, a highly experienced (i.e., 5 years) ST instructor (age 48years; height 186cm; weight 78kg) performed 12 isometric (upper limbs extended and flexed at 90°) push-up positions with different straps lengths according to the individual body height (SL%). A force plate (Twin Plates Globus, Treviso, Italy) and a piezoelectric force transducer (ISO Control Globus, Treviso, Italy) were used to evaluate the ground force (LBF) and that applied to ST (AinS Suspension Training System FIPE, Rome, Italy) device (UBF), respectively. Video recordings were analyzed to verify body alignment and to calculate body inclination (BI). Pearson correlation ascertained the relationship ( $p < 0.05$ ) between BI, SL%, LBF, UBF and total force (TF=LBF+UBF). Results Regardless of upper limbs position, high correlations ( $p < 0.0001$ ) between variables emerged. UBF (mean=41.7±10.5kg, range=20.0-53.9kg) was highly related to LBF ( $r = -0.996$ ; mean=49.1±7.1kg, range=40.6-64.0kg), BI ( $r = -0.980$ ; mean=31.6±14.2°, range=17.0-62.9°), and SL% ( $r = 0.907$ ; mean=146.4±25.0%, range=100-163%). LBF and TF (mean=90.8±3.5kg, range=84.0-95.8kg) were highly related to BI (LBF:  $r = 0.983$ ; TF:  $r = -0.952$ ) and SL% (LBF:  $r = -0.901$ ; TF:  $r = 0.897$ ). Discussion Body position is highly related with increased load on upper body. In particular, TF tends to increase towards horizontal positions, substantiating a greater muscle activation to maintain body stability (McGill et al 2014). Therefore, body position should be modified during ST to guarantee load progression and effects on strength gain comparable to traditional resistance training (Matè-Munoz et al 2014; Janot et al 2013). References Janot J et al 2013 J Fitness Res 2:23-38 Matè-Munoz et al 2014 J Sports Sci Med 13:460-468 McGill SM et al 2014 J Strength Cond Res 28:105-116 Snarr RL et al 2014 J Sport Human Perf 2:1-8 Contact c.cortis@unicas.it

#### IS THE MUSCLE LAB FORCE-VELOCITY LINEAR ENCODER ABLE TO DETECT DIURNAL VARIATION IN MUSCLE FORCE OUTPUT?

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University of Bolton

Humans are biologically weaker in the morning than the evening whilst there is convincing evidence to support both time-of-day variation of muscle force output using isokinetic and isometric methods. It is yet to be established for complex multi-joint methods used in applied practice. Therefore, the aim of this study was to assess whether the Muscle Lab force-velocity linear encoder (Ergotest version 4010, Norway), would be able to detect diurnal variation in multi-joint muscle force output. Thirty strength trained males (mean±SD: age 21.7±1.4yrs; body mass 80.5±4.5kg; height 1.8±0.1m) volunteered and were familiarized (where 1 RM was tested to ensure that the planned working loads would be well within each participant's physical ability) before completing 2 sessions at 09:00 and 17:00h (separated by 72h) counterbalanced in order of administration. Each trial involved a resting phase, 5-min cycling at 150W, then the participants performed either back squat or bench press (or vice versa) in a randomised order. Three lifts at each exercise were completed against progressively increasing loads (back squat: 20, 40 and 60kg; bench press: 30, 50 and 70kg), with 5-min rest between each lift. For back squat, the linear encoder was attached to an Eleiko Olympic bar (20kg) which was set upon rests within a standard squat rack so that the participant had a 90° knee flexion position. From this position, the participant was instructed to drive the bar upwards as forcefully as possible; the value recorded during the test was for the concentric phase of the action only. The Muscle Lab system measured both the average force produced, the peak velocity and time-to-peak velocity for each individual lift. For the bench press, the bar was set so that it rested just above (~2.5cm) the participant's chest and, again, the instruction given was to push against the bar as forcefully as possible. Rectal temperatures, ratings of perceived exertion, thermal comfort and perceived effort were measured at rest, following warm-up and after the efforts. Data were analysed by GLM with repeated measures. Trec, values were higher in the evening than the morning (~0.61°C;  $P < 0.05$ ). Bench press and back squat first and last load values showed a time of day effect with average force, peak velocity being higher in the evening and time to peak velocity lower in the evening respectively (2.2, 10.5 and 8.9%, respectively). The subjects' ratings of 'thermal comfort', 'rating of perceived exertion' and 'effort' was no different between conditions ( $P > 0.05$ ). The main finding of this study was that the Muscle Lab linear encoder is capable of detecting a daily variation of muscle force output when used with multi-joint exercises (back squat and bench press) which better resemble athletic performance. This means that the results provide more immediate translation to muscle force output both in the development of athletic ability and in their application to the demands of sport.

#### COLD WATER IMMERSION ATTENUATES PERFORMANCE INCREASES AND PROMOTES FAT LOSS FOLLOWING RESISTANCE TRAINING

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Recently, a large body of research has focused on modalities designed to hasten the recovery process, with one of the most common techniques being cold water immersion (CWI). Several studies have shown beneficial effects of CWI on recovery following a single exercise bout, however the effects of repeated CWI exposure on adaptations to exercise training are unclear. We therefore investigated the effects of CWI on body composition and performance adaptations to a resistance training program. Sixteen non-resistance trained males completed a resistance training program 3d/wk for 7 weeks. Participants were randomly allocated to CWI (10°C water) or CON (23°C room air) recovery interventions for 15 minutes, which they performed immediately following each workout. CON and CWI groups were matched for age (mean±S.D. 25.0±4.9, 20.9±3.4 years), body mass (89.2±22.7, 81.0±11.4 kg), height (1.84±0.06, 1.80±0.08 m), and chest press one-repetition maximum (1RM, 79.5±17.2, 75.6±16.0 kg). Body composition (DXA), strength (chest press and leg press 1RM), and peak force (counter-movement jump, squat jump, explosive push-up) were measured pre- and post-training. Thigh muscle temperature

was measured during the recovery intervention via an indwelling needle probe inserted 3 cm below the skin. During the recovery intervention muscle temperature decreased by  $2.48 \pm 1.30^\circ\text{C}$  in CWI and  $0.51 \pm 0.19^\circ\text{C}$  in CON ( $p < 0.05$ ). Peak force during a squat jump or explosive push-up did not change as a result of training. CWI had no effect on training induced increases in whole body lean mass, chest press 1RM, or leg press 1RM, however CWI prevented the training induced increase in peak force during a counter-movement jump (CON  $98 \pm 102$  N,  $p < 0.05$ ; CWI  $-62 \pm 103$  N,  $p = 0.13$ ). CWI also caused a decrease in whole body fat mass ( $-12.4 \pm 8.6\%$ ,  $p < 0.05$ ) whereas there was no reduction in CON ( $-4.1 \pm 10.6\%$ ,  $p = 0.10$ ). These results suggest that repeated CWI attenuates some performance adaptations to resistance training, but also causes favourable decreases in fat mass.

### **HEAVY "HYPERTROPHIC" RESISTANCE TRAINING DOES NOT INDUCE IMPROVEMENTS IN RAPID FORCE PRODUCTION IN HEALTHY OLDER MEN**

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**INTRODUCTION** Improving both maximum and rapid force production, as well as increasing muscle mass from the same training program is an attractive model for older adults to counteract the age-related decline in muscle function and size. However, it is unclear whether improved muscle activation during maximum force production (Walker & Häkkinen 2014) will transfer to improved rapid force production. The present study was carried out to determine whether it is possible to use hypertrophic resistance training alone to improve both maximum and rapid force production in untrained older men. **METHODS** Older men (60-72 yr) performed 20 weeks of "hypertrophic" resistance training twice weekly ( $n = 27$ ) or acted as a non-training control ( $n = 11$ ). Training consisted of 2-4 sets per exercise and 8-14 repetitions per set with 1-2 min inter-set rest. Lifting tempo was 2s concentric and 2s eccentric contractions. Maximum dynamic (1RM) and isometric leg press force, as well as isometric force over 0-100ms and maximum concentric power (using 50%1RM) was measured pre- and post-intervention. Surface electromyogram of the vastus lateralis (VL) and medialis (VM) muscles assessed muscle activity during these tests. Panoramic ultrasound assessed VL muscle cross-sectional area (CSA). **RESULTS** The intervention group increased their maximum isometric and dynamic force production and the changes were significantly different to control (isometric:  $12 \pm 16$  vs.  $1 \pm 9\%$ ; dynamic:  $21 \pm 12$  vs.  $2 \pm 4\%$ ). No within- or between-group differences were observed in rapid isometric force or concentric power. Increases in maximal muscle activity were greater in the intervention group than control during maximum force production only. Muscle activity during rapid force or concentric power tests did not change. Relative increases in VL CSA trended to be statistically greater in the intervention group ( $10 \pm 8$  vs.  $3 \pm 6\%$ ,  $P = 0.06$ ). **DISCUSSION** Although the present training program improved maximum force production accompanied by increased maximal muscle activity and VL CSA, the gains did not transfer over to rapid force production or muscle activity. These results support training-specific adaptations and that the intention to perform fast contractions may be critical to improve rapid force production (Behm & Sale 1993). This study provides important information for training of older individuals and it is recommended to incorporate rapid force contractions (Häkkinen et al. 1998) into training programs for this population. **REFERENCES** Behm DG, Sale DG. (1993). *J Appl Physiol*, 74, 359-368. Häkkinen K, et al. (1998). *J Gerontol A Biol Sci Med Sci*, 53, 415-423. Walker S, Häkkinen K. (2014). *J Strength Cond Res*, 28, 3041-3048. [simon.walker@jyu.fi](mailto:simon.walker@jyu.fi)

### **COMBINED PLYOMETRIC AND STRENGTH TRAINING IS SUPERIOR TO ONLY STRENGTH TRAINING ON ON-ICE SPRINT PERFORMANCE, IN NORWEGIAN U18 AND U20 ICE HOCKEY PLAYERS.**

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**Background:** Ice hockey is a sport characterized by short and frequent maximal sprints, intermitted by full stops (Montgomery, 1988, Twist and Rhodes, 1993). Due to a long season, ways to optimize on-ice sprint performance with the use of off-ice training has become an attractive field of research. Indeed, the use of plyometric exercises to improve on-ice qualities in ice hockey players has been suggested (Behm et al., 2005, Farlinger et al., 2007), but the effect of plyometric training on on-ice sprint performance is yet to be investigated. **Purpose:** The purpose of this study was to investigate whether combined plyometric and traditional strength training have a positive effect on ice hockey players' on-ice sprinting performance, when compared to traditional strength training alone. **Methods:** 16 subjects were randomly assigned to two groups. Both groups completed 5 traditional strength-training sessions per week for 8 weeks. In addition the intervention group preceded 3 of the sessions with plyometric exercises (PLY+ST), while the control group succeeded the same 3 sessions with core/stability exercises (ST). Tests of 10- and 35 meter on-ice sprint, horizontal jumping performance, 1RM squat, skating multistage aerobic test (SMAT), maximal oxygen consumption,  $10 \times 35$  sec cycling sprints and dual x-ray energy absorptometry (DEXA) was conducted before and after the intervention to assess within-group and between-group differences. **Results:** 1RM squat, fat free mass and body mass increased significantly in both groups, while maximal oxygen consumption decreased significantly in both groups ( $p < 0.05$ ). In addition, PLY+ST improved their 10 meter on-ice sprint,  $3 \times$  broad jump and  $10 \times 35$  sec cycling sprint performance significantly, while ST improved their SMAT result significantly. Significant between-group difference was only found in 10-meter on-ice sprint performance ( $p < 0.025$ ; Cohen's  $d = 1.11$ ). **Conclusion:** Combining plyometric and traditional resistance training seems to have a greater positive effect on 10-meter on-ice sprint performance than traditional resistance training alone. **BEHM, D. G., WAHL, M. J., BUTTON, D. C., POWER, K. E. & ANDERSON, K. G.** 2005. Relationship between hockey skating speed and selected performance measures. *The Journal of Strength & Conditioning Research*, 19, 326-331. **FARLINGER, C. M., KRUISSELBRINK, L. D. & FOWLES, J. R.** 2007. Relationships to skating performance in competitive hockey players. *The Journal of Strength & Conditioning Research*, 21, 915-922. **MONTGOMERY, D. L.** 1988. Physiology of ice hockey. *Sports medicine*, 5, 99-126. **TWIST, P. & RHODES, T.** 1993. **EXERCISE PHYSIOLOGY: The Bioenergetic and Physiological Demands of Ice Hockey.** *Strength & Conditioning Journal*, 15, 68-70.

### **EFFECTS OF RESISTANCE TRAINING WITH NONLINEAR PERIODIZATION ON CYTOKINES AND INSULIN RESISTANCE IN MEN WHO ARE MIDDLE-AGED AND OBESE**

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**Introduction** The study examined the effects of 3 months of the nonlinear resistance training (NRT) on serum levels of interleukin-6 (IL-6), IL-10, IL-17A, IL-20, insulin resistance, aerobic capacity and body composition in men who are middle-aged and obese. An additional aim was to determine possible associations between training-induced alterations of these cytokines and alterations of insulin resistance, aerobic capacity and body composition. **Methods** Obese men first were matched by aerobic capacity, age and percentage body fat and

then randomly assigned to NRT (n = 12) and control (CON, n = 10) groups. An age and physical activity matched control group of lean men (n = 11) were also recruited for baseline comparison. The NRT consisted of 40-65 minutes of weight training at different intensities with flexible periodization, 3 weekly sessions for 3 months (Nikseresht et al., 2014). Measures of serum cytokines, insulin resistance, body composition and aerobic capacity were obtained before and after the 12 weeks. Results At baseline, obese participants had significantly lower IL-20 and higher IL-10 than lean participants (P = 0.007 and P = 0.02, respectively), and there were negative correlations between IL-20 and each of body weight, percentage body fat, fat mass and waist circumference, but positive correlations between IL-10 and these variables (P < 0.05). Also, there were inverse correlations between insulin resistance and each of IL-10 and IL-20 at baseline (P < 0.05). After training, aerobic capacity increased significantly in NRT compared with CON (P = 0.001), which was accompanied by significant reductions in percentage body fat, waist circumference, fat mass, insulin and insulin resistance (P < 0.05). Serum IL-6 and IL-17A concentrations did not change significantly in response to training (P > 0.05), but IL-10 and IL-20 were significantly increased in the NRT when compared to the baseline level (P < 0.05). After training, changes in IL-20 concentration was negatively correlated with alterations in waist circumference (r = -0.69, P = 0.02), whereas increment in IL-10 after NRT was independent of changes in the anthropometry variables. Discussion According to this findings, it seems that the obesity induces are main factors for regulation of IL-10 and IL-20 levels. Also, the lack of significant differences for IL-6 and IL-17A between the obese and lean subjects might be due to the similar status in general health and aerobic capacity. The inverse relationship between insulin resistance and both IL-10 and IL-20 levels suggests a similar regulating role for these two cytokines. Thus, elevated IL-10 and IL-20 in men who are obese may have a compensatory role the underlying inflammation of obesity. Also, regarding the inverse relationship between IL-20 and waist circumference, it can be proposed that increased IL-20 is a positive adaptation with a likely protective role against atherosclerosis and insulin resistance. References Nikseresht, M., et al. (2014). J Strength Cond Res 28, 3399. Contact Nikserasht@gmail.com

## Oral presentations

### OP-PM24 Physiology: Hormonal biology & Gender

#### RESPONSES OF CARDIAC AUTONOMIC NERVOUS ACTIVITY, STRESS HORMONES AND PROFILE OF MOOD STATE ON DIFFERENT TRAINING PERIODS OF ELITE CROSS-COUNTRY SKIERS

Schäfer, D.1, Solberg, E.E.2, Gjerdalen, G.F.3, Herzig, D.1, Trachsel, L.1, Noack, P.4, Eser, P.1, Saner, H.1, Wilhelm, M.1

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Introduction Measuring stress in athletes is important in order to improve performance and prevent overtraining. Currently, several markers are used to monitor athletes' stress condition, but none of them have been accepted for general use. We aimed to investigate the effect of various training periods (TPs) of a cross-country skiing season on cardiac autonomic nervous activity measured by heart rate variability (HRV), stress hormones and profile of mood state (POMS) and to assess correlations between these stress markers. Methods Participants were tested during 4 different TPs of a one-year cross-country skiing season (after recovery period (RP), at the end of preparation period 1 (P1), at the end of preparation period 2 (P2) and during competition period (CP)). Urine and saliva samples were collected in the morning after waking up. Afterwards, athletes went to the lab to measure HRV in supine position and after orthostatic challenge and to answer the POMS questionnaire. Urine was analysed for adrenaline and noradrenaline concentration while saliva was analysed for cortisol and testosterone concentration. Time-domain HRV parameters were calculated. The German short-version of the POMS was used in the Swiss athletes. Time effects were analysed using repeated measures ANOVA or Friedman tests, as appropriate. Chi-square tests were used to evaluate the association in changes of the measured parameters between TPs. Results Female (n=13, 27.31±2.50 years, VO<sub>2</sub>max 62.31±5.50 ml·kg<sup>-1</sup>·min<sup>-1</sup>) and male (n=18, 22.89±4.61 years, VO<sub>2</sub>max 75.63±6.34 ml·kg<sup>-1</sup>·min<sup>-1</sup>) elite cross-country skiers from Norway (n= 14) and Switzerland (n=17) were included. HRV parameters as well as salivary cortisol and testosterone did not change between different TPs. Of the catecholamines, only adrenaline showed a significant change over time (p<0.05), with significant differences between the RP and CP [median (interquartile range): 9(34) vs. 5 (6) nmol/l and P1 and CP 17 (35) vs. 5 (6) nmol/l. There were no consistent associations between HRV parameters and catecholamines, cortisol and testosterone over the various TPs. Discussion The time pattern of adrenaline was unexpected and may be coincidental. Our results indicate that elite cross-country skiers did not experience periods of higher stress during a whole season. Moreover, we have not found any associations between HRV and cortisol, testosterone, catecholamines and the German version of the POMS.

#### THE EFFECTS OF MENSTRUAL CYCLE PHASE ON THE INCIDENCE OF PLATEAU AT VO<sub>2</sub>MAX

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Introduction The primary determinant of a maximal effort during a VO<sub>2</sub>max, is the manifestation of a plateau in VO<sub>2</sub> despite a continued increase in exercise intensity. Wide variations are reported in incidence with size and availability of the finite anaerobic capacity (AnC) proposed as the discriminating factor between responders and non-responders. A potential confounding variable in plateau generation in female participants are the metabolic and hormonal fluctuations associated with the menstrual cycle. Therefore the purpose of this study was to assess the incidence of plateau at VO<sub>2</sub>max during the stages of the menstrual cycle in a group of physically active participants. Methods 16 physically active participants, n=10 formed the non-oral contraceptive group (n-OC) (age 20.6 ± 1.6 yrs, height 169.9 ± 6.4cm, mass 68.7 ± 7.9kg) displaying regular menstrual function. Remaining 6 participants formed the oral-contraceptive control group (OC) (age 21.7yrs ± 2.16, height 168.1cm ± 6.8cm, mass 61.6kg ± 6.8kg). All reported to the laboratory on 5 separate occasions for the determination of VO<sub>2</sub>max. All trials completed on an electronically braked cycle ergometer (60-80 rpm), work-rate increasing by 0.42 W/s, plateau responses were determined using the criteria of ΔVO<sub>2</sub> <1.5 ml/kg/min. Four of the visits corresponded to menstruation (MEN), mid-follicular (mFOL), mid-luteal (mLUT) and pre-menstrual (pMEN), with the 5th a familiarization trial. OC trials were completed according to a pseudo menstrual cycle. Also recorded for the n-OC were progesterone and 17β-oestradiol. Results The ΔVO<sub>2</sub> (ml/kg/min) during the final 60 s of the incremental test for the n-OC were 0.86 ± 0.72, 1.62 ± 1.48, 1.19 ± 1.24 and 1.39 ± 1.09 for MEN, mFOL, mLUT and pMEN respectively. For the OC group the ΔVO<sub>2</sub> response for the pseudo phases were 1.46 ± 1.52 (MEN), 2.68 ± 0.28 (mFOL), 3.07 ± 1.09 (mLUT) and 2.95 ± 0.84 (pMEN). Non-significant differences were observed between phases within OC and n-OC (p > 0.05). Signifi-

cant differences witnessed for number of plateau responders between OC and n-OC for MEN, mLUT and pMEN ( $p < 0.0001$ ). Non-significant differences observed between groups and phase for VO<sub>2</sub>max, GET exercise time to exhaustion and HRmax ( $p > 0.05$ ). Discussion Data suggest the plateau in VO<sub>2</sub> during a VO<sub>2</sub>max is not affected by the phase of the menstrual cycle, of note was the significant impact on plateau response in the OC group. This is in agreement with previous work suggesting maintenance of the female sex-hormones may spare carbohydrate availability by promoting FFA metabolism reducing the availability of energy from substrate level glycolysis. Dan.gordon@anglia.ac.uk

### COMPARISON BETWEEN MUSCLE ACTIVITY AND BLADDER MOVEMENT DURING VAGINAL PRESSURE CHANGE IN PAROUS WOMEN

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(Abstract) This study was conducted to compare the activity of the abdominal and adductor muscles with the bladder base movement using transabdominal ultrasound during pelvic floor contraction between subjects who had given birth and who had not, and between subjects in various age groups. The subjects comprised 50 female adults. Classified according to the frequency of their maternal delivery and age, 17 subjects were nonparous women in their 20s and 30s (Group 1); 16 subjects were parous women in their 20s and 30s (Group 2); 17 subjects were parous women in their 40s and 50s (Group 3). All the childbirths of the parous women were vaginal deliveries. For the measurement of the contraction of the pelvic floor muscle, a vaginal pressure probe was inserted into the vagina, and the measurement was performed three times: at 10mmH<sub>2</sub>O, at 20mmH<sub>2</sub>O, and at maximum contraction. The muscle activities of the rectus abdominal muscle, external oblique abdominal muscle, internal oblique abdominal muscle, and adductor magnus muscle were measured using an electromyography. The change in the movement of the bladder base was measured using an ultrasonography. Statistical analysis of the data was performed using SPSS version 18.0. The intraclass correlation coefficient (ICC) was used to determine the reliability between the examiner. A One-way ANOVA were used to assess the statistical significance of maximum vaginal pressure between groups. A two-way repeated ANOVA was performed using the mean measurement for each task to assess for interaction between groups. Followed by the post hoc Least Square Difference (LSD). P-values < 0.05 were considered statistically significant. The study results showed that the ratios of the bladder base distance and muscle activity increased with the increase in vaginal pressure in all the three groups, but the differences among the groups were not significant. The maximum vaginal contractility was significantly higher in the non-parous women in their 20s-30s than in the parous women in their 20s-30s and 40s-50s. This indicates that parity weakens the pelvic floor muscle, resulting in vaginal contraction. The increase in the vaginal pressure of the pelvic floor muscle increased the movement of the bladder base along with the increase of the abdominal and adductor muscles' activities. Giving birth changes the body of women in many ways, especially in terms of vaginal contraction. The results of this study, however, did not show any significant difference between the results of the parous women in their 20s-30s and those in their 40s-50s. Contraction of the pelvic floor muscle was induced in this study, which resulted in the contraction as well of the surrounding muscles.

### GUIDELINES TO CLASSIFY FEMALE SUBJECT GROUPS IN SPORT SCIENCE RESEARCH

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Aim: The purpose of this paper is to systematically review current available literature regarding female subject groups in sport science in order to outline the terminology and performance indicators. Ultimately, we aim to formulate guidelines to classify female subject groups in sport science research. Furthermore, this classification system for female subject groups will be compared with the classification system for male subject groups. Methods: A database of 82 papers which described female subject groups contains information on pre-experimental maximal cycle-protocol designs, terminology, biometrical and physiological parameters, and cycling experience of female subject groups. Subject groups were divided into distinct "performance levels", according to the nomenclature. Body mass, body mass index, relative and absolute values of maximal oxygen consumption (VO<sub>2</sub>max), peak power output (PPO), and training status and history were compared between the performance levels, and between female and male performance levels using one-way ANOVA and Bonferroni post hoc test. Results: Four female performance levels were defined, representing untrained, regularly trained, well-trained and professional female subject groups. Absolute and relative values of VO<sub>2</sub>max and PPO significantly increased with the level of performance ( $p < 0.01$ ). For each performance level, significant differences were observed in absolute and relative VO<sub>2</sub>max and PPO between male and female subject groups. We propose a standardized pre-experimental test protocol for female subject groups, with an initial workload of 50W, a step increase of 25W and a step duration of 3 minutes. Relative VO<sub>2</sub>max is the most cited parameter for female subject groups and is proposed as the principal parameter to classify the female subject groups. Conclusion: This systematic review shows the large variety in the description of female subject groups in the existing literature. We propose a standardized pre-experimental testing protocol and guidelines to classify female subject groups into 4 performance levels, based on (1) relative VO<sub>2</sub>max, (2) relative PPO and (3) additional information regarding training status, absolute VO<sub>2</sub>max and absolute PPO.

### SERUM ZINC IS ASSOCIATED WITH PLASMA LEPTIN AND CU-ZN SOD IN ELITE MALE BASKETBALL ATHLETES

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Introduction Leptin, which is considered as one of the most important hormones secreted by adipose tissue (Singh et al., 2012), has been demonstrated to be vital not only in the regulation of appetite and energy balance, but also in neuroendocrine and immune functions. This paper investigates the relationship between plasma trace element and plasma leptin, as well as percent fat mass, in 16 male basketball athletes. Methods Sixteen senior elite basketball athletes participated in this study. Blood samples were obtained before intensive training and 24 h after intensive training to measure plasma zinc (Zn), copper (Cu), calcium (Ca), magnesium (Mg), iron (Fe), and leptin levels. High-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), triglyceride (TG), total and cholesterol (TC) levels were determined using commercially available kits for humans. Results Subjects presented similar values in terms of age ( $21.1 \pm 2.2$  years old), body mass index ( $23.9 \pm 2.00$  kg/m<sup>2</sup>), percent body fat ( $14.40 \pm 1.52\%$ ), plasma hemoglobin ( $150.1 \pm 9.4$  g/L), plasma Zn ( $17.47 \pm 1.28$  μmol/L), plasma Cu ( $13.42 \pm 1.40$  μmol/L), plasma Ca ( $2.41 \pm 0.14$  mmol/L), and plasma Mg ( $0.96 \pm 0.02$  mmol/L). Plasma Zn correlated positively with plasma leptin ( $r = 0.746$ ,  $P < 0.01$ ), Cu-Zn SOD ( $r = 0.827$ ,  $P < 0.01$ ), and negatively with percent fat mass ( $r = -0.598$ ,  $P < 0.05$ ) under no-training conditions. Meanwhile, plasma Cu, Ca, Mg, and Fe did not correlate with plasma leptin or percent fat mass ( $P$

>0.05). Discussion In this study, a strong positive association was found between plasma leptin levels and percent body fat levels. Previous observations relating plasma leptin to body fat percentage and body fat mass in elite volleyball trained players are partially consistent with our results (Leal-Cerro et al., 1998). Other studies observed that plasma leptin concentrations did not correlate with BMI, nor with fat percentage in professional rugby players (Magni et al., 2010). Therefore, the precise factors relevant to the determination of adipokine levels should be further investigated. As Zn acts as an inducer of metallothionein and is an integral metal of Cu/Zn-SOD, it is an antioxidant that reduces the formation of free radicals (Prasad et al., 2009). In this study, we found that plasma Zn correlated positively with Cu-Zn SOD ( $r = 0.827$ ,  $P < 0.01$ ). This result suggested that Zn is an antioxidant agent and decreases reactive oxygen species, is required for Cu-Zn SOD activity, in the Chinese men's basketball athletes. Depending on these results, we hypothesized that the activation of many zinc-dependent enzymes can become affected because of zinc deficiency in the elite men's athletes. In conclusion, plasma Zn may be involved in the regulation of plasma leptin and may serve as a lipid-mobilizing factor in Chinese men's basketball athletes.

### LONGITUDINAL ANALYSIS OF RENAL FUNCTION IN KIDNEY TRANSPLANTED SPORTSMEN

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Introduction Studies have shown that exercise only transiently alter the parameters of renal function in healthy subjects (1). However, no studies have longitudinally evaluated the effects of sport on renal function of kidney transplant recipients (KTR). In this study we analyzed longitudinally some indicators of renal function in KTR who regularly practice competitive sport with the aim to evaluate if they showed adverse effects. Methods Blood and urine test reports of 16 male KTR (mean±SD age 51±10 yrs), competing in different sport activities (climbing, cycling, swimming, tennis, track and field, and volleyball) were repeatedly collected across a five-year period. The effect of time (months after transplant) on selected blood chemistry and urine parameters was assessed using linear mixed models with random intercept on individual subjects. KTR were assuming regular immunosuppressive therapy. Weekly training sessions were recorded. Results The number of weekly training sessions was superimposable over the five years (2.9±0.7 sessions/week, 2.2±1.0 hours/session). The intercepts of haemoglobin (13.16 g/dL) and haematocrit (40.4 %) were slightly lower than the normal reference values, but these parameters did not show a significant effect of time. Urea (intercept: 49.6 mg/dL) was within the range of normality at time of transplant, and did not significantly change over time. Creatinine (intercept: 1.91 mg/dL) showed values above the normal reference values at the transplant time, but significantly decreased of -0.0037 mg/dL ( $p < 0.05$ ) per month (about 0.044 mg/dL) after transplantation, thus returning towards the range of normal values. Uric acid (intercept: 7.0 mg/dL) and urine specific gravity (intercept: 1012) were within the normal reference values and remained essentially stable over time. Discussion KTR can resume sports activities showing an overall good renal function in the five years follow up, remaining within the normal reference values. During this period, regular weekly training can be carried out with normal parameters of renal function. References 1. Bellinghieri G, Savica V, Santoro D. Renal alterations during exercise. *J Ren Nutr.* 2008; 18(1): 158-64. Contact: Valentina Totti, e-mail: trapianti@isokinetic.com

## Oral presentations

### OP-BN11 Skill acquisition

#### DEVELOPMENT OF A NOVEL SKILL ADAPTABILITY TEST FOR TALENT IDENTIFICATION IN TENNIS

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Introduction In any given sport or skill context, individuals must adapt to, and perform within a unique set of constraints which include the task, the environment and the performer's own unique characteristics (Newell, 1986). Two novel tests, a throwing and rebound task and an object striking and rebound task were created to assess the movement and skill adaptability of junior participants. The aim of this research was to establish the validity and reliability of these new tests. Methods Construct validity was assessed by comparing skilled junior athletes to a less-skilled cohort. Content validity was established via criterion-based coach rankings of athlete adaptability compared to test results. Expert tennis coaches and sport scientists provided evaluations of the tests to confirm face validity. Reliability was measured via test-retest over 3 occasions, each separated by 7-days. Results Construct validity revealed a significant effect for group with the junior athletes' superior in both tests. A Pearson's  $r$  and ICC were used to analyse content validity and reliability respectively, with both returning strong correlations. The statistical results were supplemented with the expert coaches and sport scientists confirming a high level of face validity. Discussion Current methods of talent identification (TID) in tennis are predominantly based on rankings and results despite research showing that there is no association between performances at younger ages and senior success (Brouwers, De Bosscher, & Sotiriadou, 2012). The development of skills that are essential for senior success should be the focus rather than 'winning now' (Vaeyens, Lenoir, Williams, & Philippaerts, 2008). This novel approach to TID recognises juniors that display a relatively high level of adaptable skill and movement motor skills. Adaptability has the potential to broaden the junior talent pool within tennis, as well as extending to all sports that require dynamic and time constrained perception-action, therefore it is an imperative tool for future TID programs. References Brouwers, J., De Bosscher, V., & Sotiriadou, P. (2012). An examination of the importance of performances in youth and junior competition as an indicator of later success in tennis. *Sport Management Review*, 15(4), 461-475. doi: 10.1016/j.smr.2012.05.002 Newell, K. M. (1986). Constraints on the development of coordination. In M. G. Wade & H. T. A. Whiting (Eds.), *Motor development in children: Aspects of coordination and control* (pp. 341-360). Dordrecht, Netherlands: Martinus Nijhoff. Vaeyens, R., Lenoir, M., Williams, A. M., & Philippaerts, R. M. (2008). Talent Identification and development programmes in sport. *Sports Med*, 38(9), 703-714. Contact aaron.potter@live.vu.edu.au

#### INTERMANUAL TRANSFER MECHANISMS OF FORCE FIELD ADAPTATION

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Introduction: Intermanual transfer, i.e. generalization of a motor skill across hands, is a well-accepted phenomenon. Yet, there are open questions regarding direction and magnitude of this transfer (Criscimanga-Hemminger et al., 2003; Joiner et al., 2013). Moreover, it is

unclear whether consolidation affects this transfer. Thus, the aim of this study was to investigate intermanual transfer mechanisms in a force field adaptation task with respect to direction and magnitude as well as the influence of consolidation on the transfer. Methods: 48 right-handed subjects (18-29 yrs) performed a force field adaptation task. Thereby, subjects made 2d point-to-point reaching movements at a robotic manipulandum (Shadmehr & Mussa-Ivaldi, 1994). Following familiarization and baseline measurement of both hands, subjects performed a training block (168 trials) in which they adapted their reaching movements to a force field. Afterwards, they were tested for transfer to the untrained hand. To evaluate both transfer directions, half of the subjects trained with the left (right) hand and were tested on the right (left) hand (indicated by LR and RL). To examine effects of consolidation, half of the subjects were tested for transfer 24h after training (LRc, RLc groups), whereas the other half was tested immediately after training (LRi, RLi groups). Subjects were randomly assigned to the four groups. To gauge motor performance and transfer, we used error clamp trials (Joiner et al., 2013). This allowed measurement of forces that subjects predictively generated to counteract the force field (excluding feedback mechanisms). Results: All subjects showed significant adaptation during training ( $p < .001$ ). This did not differ between hands ( $p = .086$ ). Immediately after training, the LRi ( $p = .001$ ) and RLi group ( $p = .006$ ) showed significant transfer to the untrained hand of 24% and 18%, respectively. Following consolidation period, only the LRc group showed significant transfer of 13% (LRc:  $p = .001$ ; RLc:  $p = .592$ ). Discussion: Our study is the first revealing bidirectional, though asymmetrical, intermanual transfer in a force field adaptation task. This finding contradicts former research reporting only dominant to non-dominant hand transfer (e.g. Criscimagna-Hemminger et al., 2003). Moreover, intermanual transfer seems to be a temporarily decreasing phenomenon that does not benefit from consolidation. The found bidirectional transfer might be attributed to the formation of a central internal representation (e.g. cerebellum) or interhemispheric transfer (e.g. via corpus callosum) of motor memory (Ruddy & Carson, 2013). References: Criscimagna-Hemminger SE, Donchin O, Gazzaniga MS, Shadmehr R (2003). *J Neurophysiol*, 89(1), 168-176. Joiner WM, Brayano JB, Smith MA (2013). *J Neurophysiol*, 110(4), 984-998. Ruddy KL, Carson RG (2013). *Front Hum Neurosci*, 7, 397. Shadmehr R, Mussa-Ivaldi F (1994). *J Neurosci*, 14(5), 3208-3224. Contact: stockinger@kit.edu

### MOTOR MEMORY CONSOLIDATION LEADS TO ENHANCED GAMMA BAND POWER IN THE EEG

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Introduction Motor memory consolidation describes the memory transformation from a fragile to a robust and stable state (Robertson et al., 2004). This transformation requires the adaptation of internal models. Although motor memory consolidation is frequently investigated on the behavioral level, the underlying neural processes are mostly unknown (Wolpert et al., 2011). The aim of this study was to examine power differences in the gamma bands of the human EEG due to motor memory consolidation. Methods Two groups, each containing 12 right-handed subjects, performed 2d point-to-point reaching movements handling a robotic device. Following a familiarization, both groups performed 256 trials in a force field adaptation task on day 1 and day 3. On the second day, the treatment group made 256 interfering force field movements, whereas the control group had a rest day. We recorded both handtrajectories and EEG activity of the subjects. Motor performance was quantified by the maximum perpendicular distance between the hand path and the straight line from start to target. Artifact corrected electrophysiological data were decomposed into a lower (30-45 Hz) and higher (60-85 Hz) gamma band using a multitaper approach (Mitra & Pesaran, 1999). We analyzed percentage power changes prior to movement onset and during movement execution. The kinematic and electrophysiological data were statistically analyzed using repeated measurements ANOVAs and false discovery rate to minimize the type I error. Results The kinematic data showed a significant interaction ( $p < .001$ ) between time (day 1, day 3) and group (treatment, control). Groups revealed similar performances on day 1 but the control group exhibited an increased performance on day 3 compared to day 1 while the treatment group did not. We also observed a significant interaction ( $p = .010$ ) between time and group affecting the higher gamma band prior to movement onset. The control group exhibited an increased power on day 3 compared to day 1 and the treatment group. No significant changes were found during movement execution or the lower gamma band. Discussion This is the first study which shows an association between the higher gamma band power and motor memory consolidation. This indicates different movement predictions on day 3 between groups. It might be possible that the higher gamma band serves as a neural correlate of the adapted and consolidated internal models. References Mitra PP, Pesaran B (1999). *Biophys J*, 76(2): 691-708 Robertson EM, Pascual-Leone A, Miall C (2004). *Nat Rev Neurosci*, 5(7): 576-582 Wolpert DM, Diedrichsen J, Flanagan R (2011). *Nat Rev Neurosci*, 12(12): 739-751 Contact benjamin.thuerer@kit.edu

### EFFECTS OF DIFFERENTIAL LEARNING, HIGH, AND INCREASING CONTEXTUAL INTERFERENCE ON ACQUISITION AND LEARNING OF A BASKETBALL TASK

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Introduction According to Porter and Magill (2010) motor learning is enhanced by increasing the amount of contextual interference (CI) because that way the practice schedule is gradually fitted to the changing characteristics of the learner during skill acquisition. The differential learning approach (DL; Schöllhorn, 2000) again emphasizes stochastic movement variations (changes in geometry, velocity, acceleration, and rhythm at each joint) to enhance motor learning and to cope with the constantly changing learner in order to improve situation adapted behavior (Schöllhorn et al., 2009). The following study investigates if high (random) CI, increasing CI or DL lead to different learning phenomena. Methods Thirty basketball novices were randomly assigned to three groups: Random CI, Increasing CI or DL. Participants practiced three different basketball passes (chest, overhead, single arm) over a 5-m-distance with 30 trials of each pass (90 trials in 9 blocks) on one day. Group Random CI practiced all trials randomly; group Increasing CI practiced trials 1-30 in a blocked, trials 31-60 in a serial and trials 61-90 in a random order; group DL performed 30 variations of each pass with no repetition. For each practice block the mean absolute error of pass accuracy was measured. To prove if learning occurs participants returned after one day for a retention test (9 trials, blocked order, 5-m-distance) and a transfer test (9 trials, blocked order, 6-m-distance, new but constant target). One week after the acquisition they returned to repeat the retention test and perform a second transfer test (9 trials, random order, 6-m-distance, random targets). Results No time or group effects occurred during practice (blocks 1-9). However, the analysis of the retention and the transfer tests revealed significant benefits for DL over Random CI (retention:  $p = .000$  resp.  $p = .001$ ; transfer:  $p = .001$  resp.  $p = .012$ ). Recognizable differences in the retention and transfer tests between DL and Increasing CI as well as the differences between both CI conditions were not significant. Discussion The effects of Increasing CI in this study are in line with the findings of Porter and Magill (ibid.) but cannot outperform DL. However, it seems that stochastic variations in DL are more beneficial for motor learning than switching between different as constant assumed movements (Random CI). It seems also noteworthy that in the CI conditions no CI-effect occurs but DL improves from acquisition to retention. References Porter JM, Magill RA (2010). *J Sports Sci*, 28(12), 1277-1285. Schöllhorn WI, Mayer-

Kress G, Newell KM, Michelbrink M (2009). *Hum Mov Sci*, 28(3), 319-333. Schöllhorn WI (2000). *Acta Acad Olympe Estoniae*, (8), 67-85. Contact beckmanh@uni-mainz.de

### MENTAL FATIGUE ALTERS THE DURATION OF GOAL-DIRECTED MOVEMENTS

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**Introduction** For quick and precise goal-directed movements, Fitts law, also known as the speed-accuracy trade-off, predicts that movement duration depends on target size (Fitts and Peterson, 1964). Movement duration increases inversely with the target size. Fitts law is conserved for imagined movements (Decety and Michel, 1989). With muscle fatigue, movement duration is increased, independently of the target size (Missenard et al., 2009). However, the effects of mental fatigue, induced by a prolonged cognitive task, remain unknown. The aim of the present study was to determine whether mental fatigue would increase the duration of actual and imagined goal-directed movements involving speed-accuracy trade-off. **Methods** Ten participants performed actual and imagined point-to-point arm movements as accurately and as fast as possible before and after a 90-min sustained cognitive task (Stroop task) inducing mental fatigue, and before and after viewing a neutral control task (documentary movie). Target width and center-to-center target distance varied, resulting in five different index of difficulty. Results Prior to mental fatigue, actual and imagined movement duration increased with the difficulty of the task, as predicted by Fitts' law. Mental fatigue task induced a  $4.1 \pm 0.7\%$  increase in actual movement duration and a  $9.6 \pm 1.1\%$  increase in imagined movement duration, independently of the index of difficulty. The trial-by-trial evolution of actual and imagined movement duration remained stable with mental fatigue. The control task did not induce any change in actual and imagined movement duration. **Discussion** The goal-directed movements were slowed when subjects were mentally fatigued. The increase in movement duration was independent of the target size, as it was previously observed in presence of muscle fatigue. In absence of feedback, imagined movement duration also increased. This suggested that in a mental fatigue state, proactive changes may occur during the preparatory state of the movement to preserve task success. **References** Decety J, Michel F (1989). *Brain Cogn*, 11, 87-97 Fitts PM, Peterson JR (1964). *J Exp Psychol*, 67, 103-112 Missenard O, Mottet D, Perrey S (2009). *Neuroscience*, 161, 773-786

## Oral presentations

### OP-SH12 Sports History

#### FROM PUBLIC HEALTH TO "HEALTHISM"? NEW FEMININITIES AND MASCULINITIES IN HEALTH AND FITNESS FROM 1970

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During the last decades of the 1900's, a commercial health industry transformed the previous Swedish public health regimen characterized by strong state control. Running and exercising at gyms are now widely practiced, and new products, diets and trends appear continuously. This project explores the changing discourses on health, primarily through a text and image analysis of health and fitness magazines from 1970 to the present. It fills a gap between on the one hand historical research on health in Sweden that has tended to focus on state documents and overlooked the decentralization and commercialization of health, and on the other international contemporary research on "healthism" and health/body as part of individual lifestyle projects that does not offer systematic historical analysis and contextualization. Drawing on Foucault's concept of everyday "micro power", the new masculinities and femininities – regarded as intersecting with class and ethnicity – produced here are examined. The "fit" woman is a historically new ideal, but feminists of the 'second' and 'third' waves take different views on how to judge her: is she a norm-breaking emancipatory figure, or is this just a post-feminist emancipation for the privileged classes? The male body has also become subject to more diversified norms and ideals that links together class, masculinity and exercising regimes. What liberations and what new forms of regulation can be identified in the urgings, problems and solutions formulated around health? How has the discourse on health, in Sweden historically associated with nationalism, public health and eugenics, changed with an increasingly multicultural and globalized society, marked by intensified consumption, (neo-)liberalization and the conditions of a "flexible" labour market?

#### 'WE CAN WRITE NEW HISTORY HERE'. PERFORMING HISTORY IN THE FOOTBALL ENVIRONMENT

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This abstract is based on my PhD project which investigates how history is constructed, used and performed in a context of Swedish club football. Football represents a specific structure that is embedded in a social space and reflects other cultural phenomena. Historical references are activated to define a club's character, validate its structure and also foretell its future. The process of constructing a club from the shreds of collective memory is very dynamic and creative, resulting in a plethora of interpretations and meanings, affecting the participants but also the concept of history. Clubs make up their identity by being in a constant dialogue with their own history and with other clubs. There are narratives from four Swedish clubs included in this research project: Malmö FF, Helsingborg IF, AIK and Djurgårdens IF. They all claim firm positions within the frame of Allsvenskan, as well as the regional context. These clubs devote a lot of attention to each other and thus contribute to constructing and reconstructing their identities. In this context, history tends to be produced in conflict and exchange, and in relation to other clubs. Victories, defeats, heroes and villains can come to life because of 'the other' involved in the process. The rivalry means also dependence, acceptance, inclusion and exclusion. The personal connection to a club is mediated through collective memory and the social structure around it. Throughout the football season this rapid and cyclical process is filled with tensions and emotions that help to construct new narratives and new mythologies while basing the present structure on the evaluation and re-evaluation of the past. There is not just one history, but endless versions with blurred edges and modified meanings. Further, there is the difference between using history vs. producing history. Fans and clubs do not just use the past but actively produce and perform it. The past seems as a fluid resource, responsive to interpretations and those involved in football can successfully play with its form and meaning.

## A REPERTOIRE OF POSSIBILITIES: VISUALIZED MASCULINITIES IN A SWEDISH SPORTSCLUB 1908-89

Alsarve, D.

*School of Humanities, Education and Social Sciences*

**Introduction and aim** When designing our identities we are inclined to use images of our selves, as well as pictures of 'the others'. Images are interwoven with our culture and society, as well as with definitions of history and truth. The overall aim of this study is to analyse, by using a visual method, masculinizing and de-masculinizing processes. More specific, the objective is to study how a dominant masculinity manifested itself in associative visuals (and texts), and how these images of domination changed during from 1908 to 1989. **Theory and method** Drawing inspiration from Bourdieu (2001) and Connell (1995), the theoretical perspective is based on the production and reproduction of a dominant and hegemonic masculinity manuscript at a associative level. Results from their work reveal that images and expectations about men and women make us asymmetrically associated with e. g. sexuality or age. This means that the norms of masculinity dictate how athletics are visualised or objectified. In turn, the norms and actions of masculinity are hierarchical, i.e. men see themselves in relation to a dominant masculinity or an alternative femininity. (This process always includes several other potential power perceptions.) From this perspective ideals and identities can vary both between men and within the same man, when, for example, the context changes. The method is a textual and visual analysis of how the hegemonic manuscript conditions and permeates the images and texts, e. g. in what is being captured or why, how a photograph is taken, how the athlete is portrayed and so on. More specific, the numerical representations of men and women respectively are counted along with more qualitative characteristics of how men and women were portrayed. **Results and discussion** The photography of a man always contains a potential to construct and categorise differences of gender. The ambition of the study is to say something universal about the mechanisms of the (re)production of male dominance in an organisation. The overall conclusion shows the difference in being objectified or portrayed, visually and textually, with and without respectively, a preserved subject position and status. Although, there are arguments for a changeable masculinity, sometimes the ideal masculine identity shows little variance. The changing aspects are particularly interesting as the study object grasps over an 80-year period. The discussion will focus on what power mechanisms are being used to reproduce a dominant, masculine order in the association. **References** Bourdieu, Pierre. (2001). *Masculine domination*. Cambridge: Polity. Connell, Raewyn. (1995). *Masculinities*. Berkeley: University of California Press.

## A PLACE IN THE SUN OR STANDING IN THE SHADOWS OF A GLORIOUS PAST? IDENTITY FORMATION AND FOOTBALL FAN CULTURE IN EAST GERMANY.

Glaser, J.

*Malmö university*

Football clubs in Germany have played and still play an important and vital identification role in Germany. Male football on the highest level, however, is to a large extent a western German singularity. This, I claim, is one consequence of the transformation from the state controlled socialist football of the GDR to the market-oriented capitalist football of the Federal Republic and the merger of the two German football associations in 1990. Today, there is not one football club from the former GDR in the first German league, die Bundesliga, and only two teams in the second. At the current time, the most successful teams of the GDR play in the periphery of German football, in the third or fourth league. Nevertheless, football fan culture in eastern Germany is an interesting topic, since it is a rare cultural phenomenon with its roots in the GDR that still has an impact on identity formation in unified Germany. Studying football fan culture in eastern Germany thus makes it possible not only to discern discontinuities, but more importantly continuities as well as alterations after 1989. The objective of this paper is to examine the dialectical relationship between identity formation among football fans in eastern Germany on the one hand and the German re-unification on the other. In the paper I examine how the fans articulate various dialectical relations and paradoxes such as unity and division, east and west, empowerment and disempowerment and success and failure on the football field with the purpose of understanding the attitudes of the fans towards unified Germany. The study is based on empirical data from interviews and observations carried out with football fans of BFC Dynamo, FC Erzgebirge Aue, 1. FC Magdeburg and 1. FC Union Berlin. In the analysis I use a dynamic approach to identity formation, making it possible to study to what extent identity formation and football fan culture have been affected by changing political, social, cultural and economic structures as well as different and changing discourses on nation, place and power in the wake of German re-unification. Furthermore, I investigate and challenge the common view that both the political unification and its football equivalent created either winners or losers among the East Germans. Instead I show that the narratives constructed by the interviewed football fans reveal more differentiated and changing views on the unification that depend on various relational and situated contexts.

## THE DIFFICULTY OF HITTING TWO BIRDS WITH ONE STONE – FOSTERING COMPETITIVE ATHLETES AND DEMOCRATIC CITIZENS IN A SWEDISH SPORTS CLUB BETWEEN THE 1960S AND 1980S

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*School of Health and Medical Science, School of Humanities; Education and Social Sciences*

**Introduction** According to an Official Report of the Swedish Government (SOU 2008:59) Swedish sport associations have two overriding missions: 1) to foster its members into a democratic value system and 2) to produce competitive athletes. However, there is a tension between these missions and the Swedish Sports Confederation stresses that the overall aim of the Swedish sports movement is to create a balance between these two missions. Even though a few studies have undertaken the question how the sports clubs have handled the tension (e.g. Peterson 2007), the knowledge about this area is still scarce and to reach a deeper understanding we need to scrutinize how the tension has developed over time. Therefore, the purpose of this study is to examine how a Swedish multi sectional sports club have been governing its activities in relation to the two divergent missions between the 1960s and 1980s. **Design** First, we examine the professionalization of the Swedish elite soccer coach, because it is equitable to let the coach represent the mission to produce competitive athletes. We examine what kind of knowledge constituted the elite soccer coach. Second, we examine how, in the frame of a multi sectional sports club, the professionalization of the elite soccer coach affected the activities of the youth section, which we argue represent the democratic fostering mission. To examine why and how the club governed as it did and what capital it invested in, with focus on the consequences for the elite senior soccer section on the one hand and the youth section on the other, the theoretical framework combines a foucaultian governmentality perspective (Foucault 2002) and a bourdieuan capital conceptualisation (Bourdieu 1986). The method is text analysis of educational material from coaching courses organized by the Swedish Football Association and protocols, annual reports and members review from the multi sectional sports club Örebro SK. **Result** A tentative analysis shows how ÖSK, in the pursuit of



winning, invested economic capital in elite soccer coaches. Given the academic capital they possessed through the process of professionalization the coaches could exert more power. As a consequence the objectives of the coach - to produce competitive soccer players – also formed the purpose of the activities of the youth section. References Bourdieu, Pierre. (1986). The Forms of Capital. In J. G. Richardson (Ed.), Handbook of theory and research for the sociology of education. Foucault, M. (2002). The essential works of Foucault, 1954-1984. Vol. 3, Power. London: Penguin. Idrottsstödsutredningen (2008). Föreningsfostran och tävlingsfostran. Stockholm: Fritze. Peterson, Tomas. (2007). Landskrona BoS as an Environment for Nurturing and Education. Soccer & Society, 8(1), 125-139. Contact robert.svensson@oru.se

### **EARLY SCIENTIFIC INVESTIGATIONS IN YOGA: THE MILES-BEHANAN COLLABORATION**

Mookerjee, S.1, Kornspan, A.2, Pinheiro, V.2

1: *Bloomsburg University*, 2: *University of Akron*

Introduction Empirical investigations of yogic techniques in the United States are relatively recent. In the 1930's, Professor Miles and his student, K.T. Behanan, conducted one of these earliest scientific studies of yoga at Yale University. The purpose of this treatise was to conduct a systematic review of their work based on records available at the Center for the History of Psychology, Akron, Ohio, USA. Methods A systematic, hierarchical analysis of available documentation was conducted from available archival materials, personal correspondence, data records of experiments, and published materials. All the relevant documentation was compiled and carefully reviewed by a team of three researchers. Primary sources (publications, documents, experimental data records) as well as secondary sources (correspondence) were analyzed. Results In 1931, Behanan was awarded a fellowship to conduct empirical studies in yogic techniques. Miles and Behanan made oxygen consumption (VO<sub>2</sub>) recordings of three different breathing techniques and noted significant increases in VO<sub>2</sub> - Ujayi (18-32%); Kapalbhathi (10-14%); Bhastrika (17-20%). Behanan subsequently returned to India and published a text in 1937. Miles presented and published their findings much later. Discussion With their early pioneering work, Miles and Behanan helped to stimulate a plethora of investigations in yoga. Later studies have corroborated their findings and helped clarify prevalent myths. References Behanan, KT (1964). Yoga: a scientific evaluation. 199-237. Dover Publications, New York. Hilgard, ER (1985). Walter Richard Miles 1885-1978: A Biographical Memoir, 417- 422. National Academy of Sciences, Washington DC. Miles, W. (1964). J Appl Physiol, 19:75-82.



# Friday, June 26th, 2015

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**08:30 - 10:00**

## Oral presentations

### OP-PM65 Nutrition: Hydration

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#### **THE EFFECT OF DEHYDRATION ON SIMULATED MOTOR RACING PERFORMANCE.**

Mollica, J.A., Desbrow, B., Irwin, C.G.

*Griffith University*

**Introduction** Motor racing drivers are often exposed to environments which have the potential to affect hydration status and driving performance. The aim of this study was to assess the effect of dehydration on simulated motor racing performance. **Methods** Healthy males participated in two studies investigating driving performance. Study A involved 26 participants and was designed to establish the sensitivity and reliability of performance indicators (mean lap time, mean sector time and mean distance from a corner apex) within a simulated motor racing scenario. Participants were asked to complete 2 identical driving tasks (~5mins) (with and without impaired vision) and repeated these drives following a 1 hour rest. Sensitivity was determined using paired t-tests to compare vision impaired to non-impaired vision trials. Reliability was determined by comparing non-impaired vision trials over time. Participants who met a performance criteria relating to mean lap time ( $\leq 70.00s$ ) were invited to take part in Study B. This study involved 4 participants undertaking two passive dehydration (sauna) procedures (~1% and ~3%) on separate occasions. Driving performance was assessed pre dehydration, immediately post dehydration (dehydration+heat) and following a cooling period (dehydration). Differences in the sensitive and reliable driving performance measures were assessed via repeated measures ANOVA. **Results** Study A: Mean lap time and mean sector times were found to be sensitive performance parameters relative to a likely impairment ( $p \leq 0.05$ ). However, mean distance from a corner apex was unaffected by vision impairment and hence considered an insensitive measure of driving performance for Study B. All performance parameters indicated test-retest reliability ( $p > 0.05$ ). Study B: Mean lap times were not different between pre dehydration, dehydration+heat and dehydration conditions for both 1% ( $68.56 \pm 0.81s$ ,  $68.10 \pm 0.90s$  and  $68.23 \pm 1.47s$ , respectively) and 3% trials ( $69.10 \pm 1.79s$ ,  $68.14 \pm 1.41s$  and  $68.14 \pm 1.35$ , respectively). In addition mean split times were not different between pre dehydration, dehydration+heat and dehydration conditions for both 1% ( $11.64 \pm 0.23s$ ,  $11.34 \pm 0.19s$  and  $11.47 \pm 0.34s$ , respectively) and 3% trials ( $11.56 \pm 0.23s$ ,  $11.70 \pm 0.40s$  and  $11.49 \pm 0.34s$ , respectively). **Discussion** Preliminary results suggest no impact of mild to moderate dehydration on reliable and sensitive measures of driving performance. Future analysis from a larger sample is required to elucidate the impact of hydration status on simulated motor racing performance. Contact: b.desbrow@griffith.edu.au

#### **PREHYDRATATION STATUS, FLUID AND ELECTROLYTE BALANCE IN ELITE SOCCER PLAYERS TO DIFFERENT TRAINING SESSIONS**

Boone, J., Lieven, M., Bourgois, J.

*Ghent University*

This study aimed to investigate the influence of different types of training on fluid and electrolyte balance in elite soccer players, since excessive fluid and electrolyte loss have been shown to negatively impact performance. Three training forms were included: game specific (GS), technical-tactical (TT) and endurance/core stability training (EC), which were completed in moderate temperatures ( $12 - 18^\circ C$ ) by 14 male elite soccer players. Prior to the GS training a urine sample was collected to determine urine specific gravity (PAL 10S refractometer, ATAGO, Japan) as an indication of pre-hydration status. Subjects were also weighed just before training and after showering to determine their sweat loss. The fluid and electrolyte intake was measured by weighing and analysing the concentration of the personalized drinking bottle of each player before and after training. Before the GS training sweat patches were applied to the body, which were then analysed by means of flame spectrophotometry to measure electrolyte loss. Repeated measures ANOVA was used to examine differences between training types. The USG revealed that 9 out of 14 players started training dehydrated whereof one strongly dehydrated. Players lost a substantial amount of sweat, which was significantly different ( $p = 0.005$ ) between all training types:  $1.18 \pm 0.36 L/h$ ;  $0.96 \pm 0.22 L/h$ ;  $0.65 \pm 0.27 L/h$  for GS, TT and EC respectively. Fluid reuptake was not significantly different between training types ( $p = 0.238$ ):  $72.75 \pm 38.3\%$  (GS),  $54.06 \pm 11.48\%$  (TT) and  $64.66 \pm 35.98\%$  (EC). In total, three players had a BM loss that exceeded 2%, which should be avoided. Sweat electrolyte concentration varied substantially among players:  $[Na^+]$  ranged from 437.0 to 1372.0 mg/L and  $[K^+]$  from 109 to 171 mg/L. Since water was the only consumed beverage, just a small percentage of electrolytes was replaced, respectively  $4.08 \pm 2.26\%$   $Na^+$  and  $1.36 \pm 0.72\%$   $K^+$ . Even though the importance of an adequate hydration to maintain performance is well recognized, the results of the present study indicate that more than half of the players are not optimally hydrated at the start of the GS training. Furthermore sweat rates differed between training forms and sweat electrolyte concentration varied greatly between players. Therefore an individualized hydration strategy is recommended.

#### **ALCOHOL CONSUMPTION DURING THE POST-EXERCISE PERIOD: EFFECTS ON BLOOD RHEOLOGY.**

Simmonds, M., Irwin, C., Horobin, J., Cunningham, E., Stagg, M., Desbrow, B.

*Griffith University*

Haemoconcentration and blood hyperviscosity may occur during the post-exercise period due to acute dehydration. Dehydration during and following exercise may therefore present a unique challenge to cardiovascular health given that blood hyperviscosity is also observed during short-term acute exercise even in well-hydrated individuals. Post-exercise fluid replacement is adhered to among many competitive athletes (e.g., electrolyte-rich fluids; carbohydrate/protein beverages); however, some athletes consume alcohol during the

post-exercise period. The present study investigated the level of agreement in the blood rheological response to an exercise bout that induced dehydration (~2% body weight equivalent) on two separate occasions, and also the haemorheological response to two discrete post-exercise rehydration strategies where participants consumed 150% of body weight loss as either: i. a standardised electrolyte/carbohydrate sports beverage (SB), and; ii. a commercially-available alcoholic (3.5% alc/vol) beer (beer). Blood was sampled pre- and immediately post-exercise, and also one (R1) and four hours (R4) following each exercise trial. Plasma osmolarity, blood and plasma viscosities, red blood cell (RBC) aggregation, and RBC deformability were measured within 1-h of blood collection. Repeatability of blood rheological parameters varied depending on the specific dependent variable. Plasma osmolarity significantly increased during R1 and R4 only for beer. Exercise significantly increased plasma viscosity, although no difference was detected between SB and beer. Blood viscosity (75-300 /s) was lower at R1 for SB compared with pre-exercise, but not for beer. The amplitude of red cell aggregation was increased following exercise in both conditions but returned to pre-exercise values by R1. The time course of RBC aggregation was faster post-exercise in both conditions; this returned to pre-exercise values (slower) for SB, but remained faster in beer. The findings of the present study suggest that blood rheology parameters related to low-shear flow are sensitive to fluid selection following moderate dehydration in the post-exercise period.

### IMMUNE RESPONSES AND DIETARY INTAKE OF ELITE RUGBY UNION PLAYERS DURING PRE-SEASON TRAINING

Tester, E., Jones, B., Duckworth, L., Ispoglou, T.

*Leeds Beckett University*

There is a developing base of research assessing hormonal status in rugby players as a means to monitor training and performance, however to date no research has investigated the impact of dietary intake on immunity. The objectives of the study were to monitor immune responses, as well as assess dietary intake, body composition and performance of elite rugby union players. Following ethics approval, nine players (height 185.8±6.2cm, age 28.0±3.4yrs) were assessed at the start and end of a 4-week pre-season training period for dietary intake (4-day food diary), body composition (sum of 8 [Σ8] skinfold sites), one repetition maximum (1RM) strength (bench press [BP] and prone row [PR]) and endurance (1200m run). Saliva immunoglobulin A (sIgA) measures were taken at the start and end of each week (~8.30am). Mean energy intakes were 12145.9±3772.3kJ (week 1) and 12419.7±2385.5kJ (week 4). During both weeks of dietary assessment protein and carbohydrate consumption was 2.3±0.7 and 2.7±1.1g.kg.BM<sup>-1</sup>.d<sup>-1</sup> respectively. There was a 32%, 36% and 32% contribution from protein, carbohydrate and fat to energy intake. Despite relatively low energy consumption (approximately 45% below recommendations), there was only a 0.7±2.4kg reduction in body mass (103.7±13.7 to 103±13.4kg) and a 12±2% reduction in for Σ8 skinfolds from week 1 to week 4 (106.7±44.3 to 94.17±43.6mm). Mean sIgA over the training period was 47.9±ug.min<sup>-1</sup>, with a small intra-player variability observed throughout the 4-week pre-season training period (CV 5%). sIgA was strongly correlated with fat (r=0.68) and saturated fat intake (r=0.62). sIgA was also moderately correlated with protein intake (r=0.40), Σ8 skinfolds (r=0.39) and endomorphy (r=0.43). Conversely, strong and moderate negative correlations occurred between sIgA and mesomorphy (r=-0.51), and sIgA and ectomorphy (r=-0.49). Significant improvements (P<0.05) were observed for 1RM in BP (4.0 ± 4.93 kg) and 1200m (23 ± 5.27 sec) with 1200m times strongly correlating with sIgA (r=0.56). Conversely there were moderate negative correlations between improvements in strength and sIgA (r=-0.42). In summary, players with a higher dietary fat intake and endomorphic characteristics demonstrated a better immune status than leaner ectomorphic players. Those showing better immune function also produced greater gains in endurance. The negative correlations between strength and sIgA were likely due to enhanced rates of catabolism as a result of resistance training. The pre-season training period elicited improvements in body composition despite inadequate dietary intake when compared to guidelines, highlighting the potential error of applying the recommended nutrient intake guidelines to an elite rugby union population.

## Oral presentations

### OP-PM31 Sports Medicine & Orthopedics: Physiotherapy II

#### TRAINING IN A MINIMALIST SHOE INCREASES ANKLE JOINT LOADING AND 5KM RUNNING PERFORMANCE

Fuller, J.1, Thewlis, D.1, Tsiros, M.1, Brown, N.2, Buckley, J.1

*1 University of South Australia, 2 Australian Institute of Sport*

Introduction Transitioning to less cushioned (minimalist) running shoes may promote a forefoot strike and improve running performance through greater storage and recovery of elastic energy in the ankle plantarflexors (Lieberman et al. 2010; Fuller et al. 2015). We hypothesized that a forefoot strike might increase plantarflexor loading during running training, promoting greater adaptation in these muscles and greater improvement in running performance. Methods 26 distance runners who rearfoot strike and were unaccustomed to running in minimalist footwear ran in minimalist and control shoes (order randomised) and energy absorbed and generated at the ankle joint was calculated from the integral of the ankle joint power-time curve during stance phase when running across a force platform. Stride frequency, stride length and ankle angle at initial foot contact were also calculated. An additional 50 rearfoot strike runners completed 6-weeks of prescribed running training while randomised to progressively transition to minimalist or control shoes. Running performance was assessed before and after training using a 5-km treadmill time-trial. Results Compared with the control shoe, running in the minimalist shoe resulted in more energy generation (66.8 ± 20.1 J vs 59.4 ± 14.8 J; P<0.05) but not energy absorption at the ankle joint (55.0 ± 24.1 J vs 49.4 ± 20.0 J; P>0.27). In the minimalist shoe runners ran with an increased stride frequency (87.0 ± 5.4 strides/min vs 85.5 ± 5.4 strides/min; P<0.05), decreased stride length (287.7 ± 17.8 cm vs 292.6 ± 18.4 cm; P<0.05) and a less dorsiflexed foot at initial foot contact (2.9 ± 8.9 ° vs 7.7 ± 6.3°; P<0.05). After 6-weeks of running training, runners in the minimalist shoes improved 5-km treadmill time-trial performance more than those in the control shoes (44.6 ± 38.3 s vs 24.5 ± 35.1 s; P<0.05). Discussion Running in minimalist shoes increased the energy generated by the ankle plantarflexor muscles with each stride and the number of strides taken per minute. This increased work may enhance training adaptations in the ankle plantarflexor muscles and contribute to the greater observed improvement in running performance. References Lieberman DE, et al. Nature. 2010;463:531-535. Fuller JT, et al. 2015. under review.

### COMPARISON OF HAMSTRINGS/QUADRICEPS CONVENTIONAL RATIO IN HIGH SCHOOL STUDENTS FROM 12-16 YEARS

Fagnani, P.L., López del Amo, J.L., Uviña, A., Galceran, D., Rovira, N.

*Barcelona University-INEFC*

**Introduction:** Muscular imbalance is described as a risk factor for Anterior Cruciate Ligament (ACL) lesion and can be modified by training (Sanicandro et al, 2014). Identify strength muscular differences between sexes during maturation period are fundamental for knowing the best moment for the implementation of prevention strategies in young people. The conventional Hamstrings/Quadriceps (H/Q) ratio has been used to examine muscular imbalance (Greco, Da Silva, Camarda, & Denadai, 2012, 2013). Using muscle power to assess this rate may be more appropriate than just using muscle strength, because the velocity of the execution of the movement is an important factor in the total amount of work carried out during a specific exercise (Tous, J., 1999). Therefore, the aim of this study was to measure and compare the H/Q conventional ratio between sexes and group ages from 12-16 years using the knee flexors and extensors muscles power. **Methods:** 321 Spanish high school students were separated by sexes and categorized in 5 age groups (12, 13, 14, 15 y 16 years of age) for later comparisons. The conventional H/Q ratio was calculated using the average power produced during a flexor and extensor open kinetic chain gym machines. **Results:** Significant differences ( $p < 0.05$ ) were found when comparing the H/Q ratio between sexes. Males showed in all age groups higher ratios values than women. When comparing both sexes in each age group, statistic significant differences were found in 13 ( $p = 0.022$ ), 15 ( $p = 0.008$ ) and 16 ( $p < 0.005$ ) years old. **Discussion:** Based on the results is suggested that muscular imbalance between knee flexor and extensor may persist longer in women. In this study, the bigger differences were observed in the older groups (15 and 16 years). Future studies with group ages above 16 are recommended once this study was limited to this age. **Conclusion:** Persistent muscular imbalance may be one of the risk factors for ACL rupture and may explain, in part, the higher incidence of this lesion in female adolescents. **References:** Greco, C. C., Da Silva, W. L., Camarda, S. R., & Denadai, B. S. (2012). Rapid hamstrings/quadriceps strength capacity in professional soccer players with different conventional isokinetic muscle strength ratios. *J Sports Sci Med*, 11(3), 418-422. Greco, C. C., da Silva, W. L., Camarda, S. R., & Denadai, B. S. (2013). Fatigue and rapid hamstring/quadriceps force capacity in professional soccer players. [Comparative Study Research Support, Non-U.S. Gov't]. *Clin Physiol Funct Imaging*, 33(1), 18-23. doi: 10.1111/j.1475-097X.2012.01160.x Sannicandro I., Cofano G., Rosa RA., Piccinno A. (2014). Balance training exercises decrease lower-limb strength asymmetry in young tennis players. *J Sports Sci Med*. 2014 May 1; 13(2):397-402. eCollection. Tous, J. (1999). Nuevas tendencias en fuerza y musculación. Barcelona: Ergo. † insert authors here

### WORSE SELF-REPORTED OUTCOMES BUT NO LIMITATIONS IN PERFORMANCE BASED MEASURES IN PATIENTS WITH LONG-STANDING HIP AND GROIN PAIN COMPARED WITH HEALTHY CONTROLS

Ageberg, E., Wörner, T., Sigurdsson, H.B., Pålsson, A., Kostogiannis, I.

*Lund University*

**Purpose** The aim of this cross-sectional study was to evaluate lower extremity and trunk muscle function as well as patient reported outcomes in people with long-standing hip and groin pain (LHGP) in comparison to healthy controls. We hypothesized that individuals with LHGP would report more deficiency on the Copenhagen Hip and Groin Outcome Score (HAGOS) and have worse trunk and lower extremity performance than controls. Participants with LHGP were also expected to have worse lower extremity function on their symptomatic compared with their non-symptomatic limb. **Methods** Nineteen participants with LHGP and 19 controls matched for activity level, age, gender, and weight reported their hip and/or groin disability and associated problems on the HAGOS questionnaire. Lower extremity and trunk muscle function was assessed by means of a parallel squat (w/kg), single leg triple jump (cm), single leg rise (n), barbell rollout (% of height), and plank-test (s). **Results** Participants with LHGP had worse scores than controls in all HAGOS-subcales ( $p \leq 0.001$ ). The smallest difference was observed for subscale activities of daily living [mean diff 19.21 (95% CI 9.73 to 28.69)] followed by subscales pain [mean diff 29.63 (95% CI 20.00 to 39.26)], symptoms [mean diff 28.74 (95% CI 19.62 to 37.86)], sports and recreation [mean diff 36.95 (95% CI 25.00 to 48.89)], physical activity [mean diff 46.61; 95% CI 28.83 to 64.38]], and quality of life [mean diff 57.37 (95% CI 47.40 to 67.33)]. No differences were observed for the parallel squat [mean diff 0.89 (95% CI -2.93 to 1.14) w/kg], single leg triple jump [mean diff 20.5 (95% CI -88.6 to 47.5) cm], single leg rise [mean diff 3.6; 95% CI -11.3 to 4.1] n], barbell rollout [mean diff 0.2 (95% CI -4.8 to 5.1) % of height], or the plank test [mean diff 8.8 (95% CI -54.1 to 36.5) s]. Furthermore, no differences were observed between symptomatic and asymptomatic limbs of participants with LHGP in the single leg triple jump [mean diff 1.4 (95% CI -17.16 to 19.96) cm] or the single leg rise [mean diff 1 (95% CI -2.47 to 4.27) n]. **Conclusions** Despite significant self-reported limitations and associated hip/groin problems, there were no significant differences between groups in strength, power or performance-based measures. The greatest limitations were reported in physical function sports, physical activity, and quality of life. Future studies with larger sample sizes are needed to explore whether other measures of muscle function may detect possible sensorimotor deficiencies in people with LHGP.

### EMG ACTIVITY OF THE UPPER TRAPEZIUS, LOWER TRAPEZIUS AND SERRATUS ANTERIOR IN ASYMPTOMATIC COLLEGE BASEBALL PLAYERS AND ONE CASE IN A PITCHER WITH SCAPULAR DYSKINESIS

Tsuruiki, M.I., Ellenbecker, T.S.2

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**Introduction** Scapular dyskinesia (SD) has been suggested to be associated with a decrease in subacromial space width, modification of scapular muscle activity, and glenohumeral (GH) joint congruency problems. The purpose of this study was to identify the muscle activity of the upper trapezius (UT), lower trapezius (LT), and serratus anterior (SA) with different weight intensities in shoulder flexion. It was also to compare these muscle activities between the asymptomatic group means and one active pitcher with type II Kibler SD (Kibler et al., 2013). **Methods** Twenty nine active college baseball players volunteered to be tested in this study. All subjects performed isotonic contractions of shoulder flexion for 3 consecutive repetitions with no weight (0 kg) and an adjustable wrist cuff weight ranging between 1.8 kg and 3.2 kg. The subjects completed each of the exercises in upward motion and descent each for 5 seconds with an interval of 10 seconds between each of the repetitions. A metronome with a frequency of 1 Hz was used to standardize the speed of exercise. Raw EMG amplitudes of the UT, LT, and SA muscle were collected in each testing session and normalized by the MVIC of the corresponding muscle (%). This study analyzed each of the mean values blocked at every 1 second in both upward motion and descent. A repeated measures ANOVA design was used to examine differences for the asymptomatic group ( $n=28$ ). **Results** The mean value of UT EMG activity in the dominant side (DOM) with the intensity of 0 kg and 3.2 kg was significantly smaller than that of the non-dominant side (NON) (34% and 41% versus 48% and 52% with 0 kg and 3.2 kg respectively) ( $p < .05$ ). In contrast, the mean value of LT EMG activity in DOM with the intensi-

ties of 0 kg and 3.2 kg was significantly greater than that of the NON (29% and 33% versus 23% and 27% with 0 kg and 3.2 kg respectively) ( $p < .05$ ). The EMG activity with 1.8 kg in the DOM was significantly smaller than that of the NON (24% versus 30%) ( $p < .05$ ). The subject with the type II SD hyper-activated the UT muscle in the DOM in both upward movement and descent regardless of the intensities, whereas the subject hypo-activated the LT muscle in DOM with the intensity of 3.2 kg in descent. Discussion This study suggests that the intensity of 3.2 kg is used for SD testing in overhead athletes. This study also speculates the mechanism of the subject with the type II SD is attributed for a decrease in the LT muscle activity in descent as intensity increases. Reference Kibler WB, Ludewig PM, McClure PW, Michener LA, Bak K, Sciascia AD. (2013) Br J Sports Med, 47(14), 877-885.

### UPPER AND LOWER EXTREMITY EXPLOSIVE POWER AND MOVEMENT QUALITY IN MALE AND FEMALE YOUTH TEAM HANDBALL PLAYERS

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**Introduction** Training programs that are sport specific and address the muscular demands of the sport may improve overall motor control, thereby enhancing performance, as well as decreasing injury risk. First, however, there is a need to understand muscular function in relation to specific sports, gender, and age. **Aim** The purpose was 1) to evaluate upper and lower extremity explosive power and movement quality, and 2) assess any gender differences in youth handball athletes. **Methods** Thirty-one handball athletes (18 females, 13 males) mean age 13 years (SD 1.0), included in an ongoing study, were assessed. Four previously evaluated muscle function tests were used to challenge lower and upper extremity explosive power and movement quality: 1. Explosive power assessed by single leg counter-movement jump (SLCMJ); 2. Visual rating of knee position relative to foot (good or poor) during single limb mini squat (SLMS) and SLCMJ; 3. Explosive power during the overhead medicine ball throw (MBT); 4. Visual rating of shoulder movement quality during arm movements (good or poor) using the scapular dyskinesis test (SDT). Spearman's rank correlation coefficient was used to assess associations. Fisher's exact test was used to compare groups. **Results** The correlation between upper and lower extremity explosive power was  $r = 0.436$  ( $p = 0.014$ ). The correlation between lower extremity explosive power and movement quality was  $r = 0.329$  ( $p = 0.071$ ), between upper extremity explosive power and movement quality  $r = 0.342$  ( $p = 0.342$ ) and lower extremity movement quality and upper extremity movement quality  $r = 0.338$  ( $p = 0.063$ ). Males jumped higher than females, 17.9 cm (SD 4.0) vs 13.8 cm (SD 3.5) ( $p = 0.003$ ), but there was no gender difference in upper extremity explosive power (males 646.5 cm (SD 71.76) vs females 642.8 cm (SD 83.6),  $p = 0.828$ ). There were no gender-differences in upper extremity movement quality, 7.7% males and 11.1% females scored good and 92.3% males and 88.9% females scored poor ( $p = 0.624$ ). No gender-differences were observed in lower extremity movement quality, 46.2% males and 50% females scored good and 53.8% males 50% females scored poor ( $p = 0.561$ ). **Conclusions** Our preliminary results indicate a weak to moderate association between overall upper and lower extremity explosive power in youth handball athletes. The only gender-difference was in jump height. This is supported by previous research, which suggests most gender differences are evident after puberty. A high number of males and females scored poor upper and lower extremity movement quality, suggesting that this is an important factor that needs to be addressed in handball training programs in this age group. The relation between muscle function and sport-specific performance remains to be determined. Contact sm.cristovao@gmail.com laurajess5@gmail.com

### EFFECT OF WEIGHT-BEARING EXERCISE ON FOREARM BONE SITES OF HANDBALL AND SOCCER FEMALE PLAYERS

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**INTRODUCTION:** This pilot study investigates the effect of weight-bearing sports on the modeling activity of both specific and non-specific bone sites, comparing side to side within and among trained and non-trained groups, controlling for lifestyle and maturation stage at the beginning of sport training. **METHODS:** BMD, T- and Z-score at distal forearm regions were evaluated in 30 female handball players (HP, 22.3±3.9 years), 30 female soccer players (SP, 22.2±3.6 years), who have been training for 7.7±3.8 years, 12 hours per week, as well as in 30 untrained females (CG, 23.9±3.2 years). **RESULTS:** In handball players, the BMD of the dominant forearm was 21.5% and 11% higher than in the CG and SP, respectively. No difference in the dominant arm BMD between SP and CG. BMD of the non-dominant forearms showed no differences between athletes groups, while it showed a significant increase compared with the CG (HP: +18.3%; SP: +10.6%). SP who had started their carrier before menarche, showed a non-dominant arm BMD 5.5% greater than those SP who started after it. Moreover, the dominant arm BMD was 12% (+2.5%) higher compared with CG, showing any significant differences compared with the corresponding forearm in HP. Even the non-dominant arm BMD was further increased, passing from 10.6 at 13.5% (+2.9%). Less marked was the increase in BMD of both HP forearms (+1.4%). **CONCLUSION:** This pilot study demonstrated that weight-bearing sport training induces a beneficial effect not only at level of specific skeletal regions but even in non-weight-bearing sites, such as both forearms of SP, whose BMD was further improved, especially for the dominant side, in females who started to play at menarche or before it. In fact, we showed for the first time that not only HP with approximately 8 years of regular sport participation had the maximally beneficial for mineralization at bone sites directly involved in the sport activity, but that regular participation to weight-bearing exercise positively affects non-weight-bearing bone sites, such as the upper forearms of the SP, through both direct mechanical loading and/or systemic skeletal adaptation to exercise.

## Oral presentations

### OP-PM27 Sports Medicine & Orthopedics: Orthopedics I

#### NO INTEREST FOR A SECOND CLOSELY-TIMED INFILTRATION OF PLATELET-RICH PLASMA TO TREAT JUMPER'S KNEES

Kaux, J.F., Croisier, J.L., Forthomme, B., Le Goff, C., Buhler, F., Savanier, B., Delcour, S., Gothot, A., Crielaard, J.M.

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**Introduction:** Some clinical series have evaluated the effect of platelet-rich plasma (PRP) in the treatment of jumper's knee. Although it is possible that a single infiltrative administration may prove to be an effective treatment for this indication, most of the existing studies evaluated the effects of 2 or 3 successive infiltrations. The aim of this study was to evaluate whether 2 infiltrations of PRP proves more

effective than a single treatment. Methods: Twenty patients suffering from chronic jumper's knee were enrolled into our prospective, randomized and comparative study of level 2, and split into two randomized groups (1 or 2 infiltrations of PRP, respectively). The 3-month follow-up evaluation consisted of VAS, IKDC and VISA-P scores, along with algometer, isokinetic and ultrasounds evaluations. After 1 year, subjects were contacted to define their functional evolution. Results: The concentration of the PRP used for each infiltration was similar in both groups, and contained no red or white cells. Results revealed no difference in treatment efficacy between the groups. Discussion: The comparison between 1 or 2 infiltrations of PRP did not reveal any difference between the 2 groups at short to mid term. A second closely-timed infiltration of PRP to treat jumper's knees is not necessary to improve the efficacy of this treatment in the short term. References: Kaux JF, Croisier JL, Bruyere O, Rodriguez de la Cruz C, Forthomme B, Brabant G et al. One injection of platelet-rich plasma associated to a submaximal eccentric protocol to treat chronic jumper's knee. *J Sports Med Phys Fitness*. 2014 Jun 19. [Epub ahead of print]. Kaux JF, Croisier JL, Forthomme B, Le Goff C, Buhler F, Savanier C et al. Using platelet-rich plasma to treat jumper's knees: exploring the effect of a second closely-timed infiltration. *J Sci Med Sport*. Submitted. Kaux JF, Bruyère O, Croisier JL, Forthomme N, Le Goff C, Rohr N et al. One-year follow-up of platelet-rich plasma infiltration to treat chronic upper patellar tendinopathies. *Acta Orthop Belg*. In press. Contact: Physical Medicine and Sports Traumatology Department, University and University Hospital of Liège, Liège, Belgium, jfkau@chu.ulg.ac.be

## ACUTE AND OVERUSE INJURIES IN SWISS ORIENTEERING ATHLETES

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**Introduction** In the final ranking of the International Orienteering Federation World Cup 2014 Switzerland was classified as the best nation with 5 women in the top 12 and 7 men in the top 15. A great part of the weekly orienteering training is performed as endurance running training. However, a high weekly running mileage puts considerable stress on the athlete's musculoskeletal system (Jones et al., 1994). A consequence thereof are acute and overuse injuries. Hence, the aim of this study was to determine the injury incidence rate and injury pattern in Swiss elite orienteering athletes. **Methods** The injury data were collected retrospectively for the years 2005-2014 from volunteering, current and former, athletes of the Swiss Orienteering Federation. The athletes' medical records were used to classify injuries according to the Orchard Sports Injury Classification System (OSICS version 10.1). The training data were collected from the athletes' digital training diary and matched for age. The data are presented as mean  $\pm$  standard deviation, proportions of injuries by anatomical region, type and onset of injuries. **Results** The data of 30 athletes aged  $22 \pm 3.2$  years (range 18-30), were recorded. A total of 175 injuries were assessed. The most commonly affected anatomical region was the lower extremity (92.6%). Thereof, the knee (29.1%), the lower leg (20.0%) and the foot (18.9%) were injured most. The most common types of injury were pain and/or inflammation (65.1%), sprains (11.4%) and dislocations (9.1%). Almost two thirds (61.1%) of all injuries were classified as overuse injuries. About a third of injuries (28.6%) resulted in training days lost. The mean injury incidence risk for athletes aged 18-23 years was  $3.1 \pm 3.1$  injuries per 1000 training hours. No significant relation between training volume (380.8  $\pm$  77.1 hours per year) and injury risk was found. **Discussion** A high amount of running based training is a risk factor for musculoskeletal injuries. This was confirmed in the present study with the great amount of lower extremities injuries, most of them due to overuse onset. Previous studies with recreational runners reported 2.5-12.1 and 10.0 injuries per 1000 hours of training, and the knee as the most commonly affected region (van Mechelen, 1992; Hespanhol Jr., et al. 2013). Concluding, the Swiss elite orienteers display a rather low injury incidence rate within the former reported range, and further, the injury patterns are in line with previous results. **References** Hespanhol Jr., LC., Pena Costa, LO., Lopes, AD. (2013). *J Physiother*, 59(4):263-269. Jones, BH., Cowan, DN., Knapik, JJ. (1994). *Sports Med*, 18(3):202-214. van Mechelen, W. (1992). *Sports Med*, 14(5):320-335. Contact Lilian.Roos@baspo.admin.ch

## ALTERED LUMBO-PELVIC CONTROL IN INDIVIDUALS WITH PATELLOFEMORAL PAIN SYNDROME

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**Introduction** Clinically, altered movement patterns are commonly addressed in the treatment of patello-femoral pain (PFP). Whilst there is evidence for decreased hip muscle strength and control in PFP [1-5] and altered trunk control [4, 6], the findings are not conclusive [4, 7]. Most studies have focused on hip movement control and strength with little attention paid to lumbo-pelvic control in PFP. This study aimed to investigate lumbo-pelvic control during functional tasks in females with and without PFP. **Methods** Lumbo-pelvic motion was measured using DorsaVi Movement sensor technology in 17 individuals with PFP and 10 healthy controls. Lumbar flexion range of movement and lateral pelvic tilt was assessed during three functional movements; a double leg squat, a single leg lunge and a hurdle step. Reliability was assessed with the 10 control subjects returning for repeat testing 1 week after initial testing. **Results** Reliability analyses indicated good to excellent reliability (ICC range (0.72-0.95%) for the three tests. Individuals with PFP demonstrated increased range of lumbar flexion and pelvic lateral tilt during the single leg lunge ( $P < 0.05$ ). In the double leg squat individuals with PFP completed the movement with less lumbar flexion ( $p < 0.05$ ). Whereas during the hurdle step, individuals with PFP completed the movement with less lateral flexion than control participants. **Conclusions** Participants with PFP were found to have altered lumbo-pelvic control when compared to healthy controls. These findings indicate that lumbo-pelvic control may be an appropriate rehabilitation focus for individuals with PFP. **References** 1. Magalhaes E et al. A comparison of hip strength between sedentary females with and without patellofemoral pain syndrome. *J Orthop Sports Phys Ther* 2010; 40: 641-647. 2. Nakagawa T et al. Trunk, pelvis, hip, and knee kinematics, hip strength, and gluteal muscle activation during a single-leg squat in males and females with and without patellofemoral pain syndrome. *J Orthop Sports Phys Ther* 2012; 42: 491-501. 3. Bolgia LA et al. Hip strength and hip and knee kinematics during stair descent in females with and without patellofemoral pain syndrome. *Journal of Orthopaedic & Sports Physical Therapy* 2008; 38: 12-18. 4. Cowan SM et al. Altered hip and trunk muscle function in individuals with patellofemoral pain. *British Journal of Sports Medicine* 2009; 43: 584-588. 5. Brindle TJ et al. Electromyographic changes in the gluteus medius during stair ascent and descent in subjects with anterior knee pain. *Knee Surgery Sports Traumatology Arthroscopy* 2003; 11: 244-251. 6. Negahban H et al. The effects of muscle fatigue on dynamic standing balance in people with and without patellofemoral pain syndrome. *Gait & Posture*, 2013; 37: 336-339. 7. Hollman JH et al. Frontal and transverse plane kinematics and gluteus maximus recruitment correlate with frontal plane knee kinematics during single-leg squat tests in women. 2014; 29(4): 468-474

## ONE WEEK OF HOSPITAL ADMISSION FOLLOWING ELECTIVE HIP SURGERY INDUCES SUBSTANTIAL MUSCLE ATROPHY IN OLDER PATIENTS

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**Introduction:** It has been suggested that short successive periods of muscle disuse, due to injury or illness, may contribute significantly to the observed loss of muscle mass over the lifespan. Hospitalization of older individuals due to acute illness, injury or (elective) surgery generally results in a mean hospital stay of 5-7 days during which the level of physical activity is strongly reduced. We hypothesized that hospital admission for elective hip arthroplasty is accompanied by substantial muscle atrophy in older men and women. **Methods:** Twenty healthy older patients (77±1 y) undergoing elective total hip replacement surgery participated in this observational study during hospital admission. Prior to surgery and before discharge CT scans were performed to assess muscle cross-sectional area (CSA) of both legs. During surgery and prior to hospital discharge a muscle biopsy was taken from the M vastus lateralis of the operated leg to assess muscle fibre type-specific CSA and myonuclear content. Repeated measures ANOVA with time and leg as within-subjects factor were used, with separated T-tests being performed for each leg when interaction was observed. **Results:** An average of 5.8±0.4 days of hospital admission resulted in a 3.8±1.1 and 5.1±1.3 % decline in quadriceps muscle and whole-leg muscle CSA, respectively, in the control leg when compared with baseline values (P<0.05). Oedema in the operated leg resulted in a 9.3±1.6 % increase in leg CSA (P<0.05). Muscle biopsies from the operated leg are currently being analysed for muscle fibre type characteristics. **Conclusions:** Six days of hospitalization following elective hip arthroplasty leads to substantial leg muscle atrophy in older patients. Effective strategies are warranted to prevent the loss of muscle mass and strength induced by short periods of muscle disuse during hospital admission. Email: im-re.kouw@maastrichtuniversity.nl

## EFFECTS OF ANKLE SUPPORT ON THE GROUND REACTION FORCE DURING THE REPEATED SIDE STEP

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**[Introduction]** External ankle supports are commonly used to prevent injuries during sports activity because it helps to increase the stability of ankle joint movement (Eils and Rosenbaum, 2003). Ankle supports can limit the frontal plane motion of the ankle joint during the landing tasks of locomotion (Vanwanseele et al., 2013) and significantly reduce the risk of ankle sprains particularly in athletes with a history of ankle injury (Siller et al., 1994). In contrast, the limitation of ankle movement by ankle brace affects to the athletic performance (Koyama et al. 2014; Yamauchi and Koyama in press). Also, ankle support stabilizes the inversion and eversion at the ankle joint, thus it may decrease the ground reaction force and limit the performance in the side step movement. However, there is no clear evidence how ankle support affects the ground reaction force during the repeated side step. **[Purpose]** The purpose of this study was to investigate the effects of ankle support on the ground reaction force during the repeated side step. **[Methods]** Ten healthy men (age, 21.8±1.0 years; height, 1.74±0.05 m; body mass, 67.8±12.2 kg; mean±SD) performed the repeated side step without or with ankle brace of the right ankle joint in random order on the same day. They were instructed to move laterally among three lines as quickly as possible for 20 s and to naturally contact with right foot within the area of the force plate (Kistler, Switzerland) at 1 kHz. Three parallel lines were set 1 m apart from each other, and they stepped sideways from one line to the other line. The number of times the subjects crossed the lines was counted. Trials were performed each condition with sufficient time for recovery between trials. Mediolateral ground reaction force (GRF) during foot contact was calculated for contact time (CT), first GRF (FGRF), time between contact and FGRF ( $\Delta t$ ), second GRF (SGRF), mediolateral impulse (MI). All data were presented as the mean of the 5 GRF data. **[Results]** The number of times, CT, FGRF, SGRF and MI were not significantly different between barefoot (Number; 46.8±5.8 times, CT; 0.26±0.04 s, FGRF; 398.2±150.9 N, SGRF; 499.1±83.4 N, MI; 74.9±20.0 Ns) and ankle brace (Number; 46.9±4.2 times, CT; 0.26±0.04 s, FGRF; 372.8±154.2 N, SGRF; 499.8±72.9 N, MI; 72.8±20.4 Ns).  $\Delta t$  was significantly lower in ankle brace (0.036±0.018 s) compared with barefoot (0.045±0.018 s). **[Conclusion]** These results suggest that ankle support did not decrease developing force of mediolateral direction in repeated side step due to increase in stability at the ankle joint. **[References]** Eils E, Rosenbaum D (2003). *Foot Ankle Int*, 24(3), 263-268. Koyama K, Kato T, Yamauchi J. (2014). *J Strength Cond Res*, 28(5), 1411-1417. Siller M, Ryan J, Wheeler B, McBride J, Arciero R, Anderson J, Horodyski M (1994). *Am J Sports Med*, 22(4), 454-461. Vanwanseele B, Stuelcken M, Greene A, Smith R (2014). *J Sci Med Sport*, 17(5), 511-515.

## LOW BACK AND NECK & SHOULDER PAIN IN ADOLESCENT SPORTS CLUB PARTICIPANTS AND NON-PARTICIPANTS. THE NATIONAL HEALTH PROMOTING SPORTS CLUB STUDY.

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**LOW BACK AND NECK & SHOULDER PAIN IN ADOLESCENT SPORTS CLUB PARTICIPANTS AND NON-PARTICIPANTS.** The national Health Promoting Sports Club (HPSC) Study. **Introduction** The objective of this study was to investigate the prevalence of self-reported low back (LBP) and neck & shoulder (NSP) pain and related factors in adolescent sports club participants and non-participants. **Methods** This cross-sectional study was based on surveys among 14-16 year-old adolescents as a part of the national Health Promoting Sports Club (HPSC) Study. The surveys on self-reported health behaviors, injuries and musculoskeletal health were conducted in sports club participants (n=988) and non-participants (n=705). **Results** Prevalence of LBP during preceding 3 months was 63.2% in girls and 44.5% in boys (p<0.05 for sex difference). Also the prevalence of NSP was higher in girls (74.3%) than in boys (52.5%) (p<0.001). Non-participants to sports clubs had higher prevalence of NSP than sports club participants (68.5 % vs 61.1%, p<0.02). LBP prevalence was higher in sports club male participants (49.6% vs 37.3%, p<0.02). Sports club participants who reported to have had LBP ever trained more often (times/wk) during training season (mean (sd) 4,8 (2,2) vs 4,4 (2,0), p<0.02) and in competition season (mean (sd) 5,2 (2,7) vs 4,8 (2,3), p<0.02), had had more competitions and/or games during the last 12 months (mean (sd) 24,5 (22,7) vs 20,9 (20,4), p<0.02) and fewer rest days in training (mean (sd) 2,2 (1,2) vs 2,5 (1,4), p<0.001) and competition seasons (mean (sd) 2,0 (1,2) vs 2,3 (1,4), p<0.001). No associations were found between leisure-time physical activity and LBP or NSP. High screen time (computer games, TV/DVD, phone, Internet) during leisure-time increased slightly the odds for LBP (OR 1.04 95% CI 1.003-1.071 as calculated per additional hour of inactivity). **Discussion** Self-reported low back pain and neck and shoulder pain are fairly common already among adolescents. Girls are at more risk in reporting



LBP and NSP. Our results also suggest that the prevalence of LBP is higher in male sports club participants and NSP among non-participants in general. Contact: marleena.k.rossi@student.jyu.com

## Oral presentations

### OP-PM15 Physiology: Hypoxia

#### EFFECTS OF ALTITUDE ACCLIMATIZATION ON SPLEEN VOLUME AND CONTRACTION DURING SUBMAXIMAL AND MAXIMAL WORK IN LOWLANDERS

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**Introduction** Release of stored erythrocytes resulting from spleen contraction improves human performance in various hypoxic situations, and it was recently reported that a 2 month climb of Mt Everest augmented the spleen contraction (Engan et al., 2014). Our aim was to study if a shorter climb to moderate altitude would affect the spleen contraction and Hb increase seen with exercise. **Methods** Five men and two women aged 23(4) years, performed the following protocol before and after a trek to a maximal sleeping elevation of 5200 m during 6 weeks in Nepal: 10 min rest, a submaximal treadmill test (modified Bruce treadmill protocol) involving 4 x 4 min work and 1.5 min rest between workloads, 10 min rest, a maximal treadmill test, follow by 10 min rest. Spleen volume was measured by ultrasonic imaging at each resting period, and venous blood samples were drawn for hemoglobin (Hb) concentration before and after each exercise test. **Results** Mean(SD) baseline spleen volume was 193(40) mL before and 270(94) mL after the trek ( $P < 0.05$ ). Baseline Hb was 146.6(11.7) before and 152.1(15.1) g/L after the trek ( $P = 0.15$ ). After submaximal work, spleen volume had decreased by 46(15) mL before the trek, and by 106(47) mL after the trek ( $P < 0.05$ ). After submaximal work, Hb had increased to 153.6(15.0) g/L before- and 162.7(16.7) g/L after the trek (both  $P < 0.05$ ). After maximal work, spleen volume had decreased by 66(21) mL before the trek, and by 116(61) mL after the trek ( $P < 0.05$ ). After maximal work, Hb had increased to 154.4(9.8) g/L before- and 164.2(16.4) g/L after the trek (both  $P < 0.05$ ). **Conclusion** Spleen volume during rest was larger and Hb was slightly enhanced after the high altitude trek. Both spleen contraction and elevation of Hb during exercise were enhanced after the trek. We conclude that the contraction of the spleen during exercise is enhanced in lowlanders as a result of altitude acclimatization. This aligns with observations by Engan et al. (2014) during a Mt Everest climb, despite the shorter duration and more moderate altitude exposure of the current study. The observation of a larger spleen during rest after high altitude acclimatization is novel. A larger storage of erythrocytes in the spleen during rest could serve to lower the blood viscosity associated with polycythemia after high altitude acclimatization. **Reference** Engan HK, Lodin-Sundström A, Schagatay F, Schagatay E. (2014). The effect of climbing Mount Everest on spleen contraction and increase in hemoglobin concentration during breath holding and exercise. *High Alt Med Biol* 15(1), 52-57.

#### SIMILAR INCREASE IN HEMOGLOBIN MASS WITH "LIVE HIGH TRAIN LOW" IN NORMOBARIC AND HYPOBARIC HYPOXIA

Hauser, A.1,2, Saugy, J.J.2, Schmitt, L.3, Cejuela, R.4, Trösch, S.1, Faiss, R.1, Wehrlin, J.P.1, Millet, G.P.2  
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1Swiss Federal Institute of Sport Magglingen, Switzerland; 2University of Lausanne, Switzerland; 3National Ski-Nordic Centre, France; 4University of Alicante, Spain **Introduction** For elite endurance athletes the primary aim of the live high train low (LHTL) altitude training strategy is to improve sea-level endurance performance. The main underlying physiological mechanism is an increase in hemoglobin mass (Hbmass) (Schmidt & Prommer, 2008). A wide range of athletes use technical devices to simulate altitude (normobaric hypoxia: NH). However, so far no study compared the effect of LHTL in NH or LHTL at real altitude (hypobaric hypoxia: HH) with the same hypoxic dose. The aim of this study was therefore to compare Hbmass changes during an 18-days LHTL training camp in either NH or HH with endurance athletes. **Methods** Twenty-eight well-trained male triathletes were split into three groups (NH:  $n = 10$ , HH:  $n = 11$ , control (CON):  $n = 7$ ) and participated in an 18-days LHTL camp. NH and HH slept at 2250 m whereas CON slept and all groups trained at  $< 1200$  m. Hbmass was measured in duplicate with the optimized CO-rebreathing method pre-, post (NH:  $238 \pm 10$  h; HH:  $316 \pm 2$  h) and at day 13 in HH (similar hypoxic dose  $229 \pm 1$  h as in NH) of the altitude training camp. Running (3-km run) and cycling (incremental cycling test) performance were only evaluated pre and post. Two-way ANOVA for repeated measures and Cohen's effect size (d) (Cohen, 1988) were calculated. **Results** After 18-days, both HH (+4.5%,  $d = 0.5$ ,  $P < 0.001$ ) and NH (+4.1%,  $d = 0.5$ ,  $P < 0.001$ ) increased their Hbmass to a moderate extent, whereas the change for CON was small (+1.9%,  $d = 0.1$ ,  $P = 0.08$ ). Hbmass change did not differ between the groups ( $P = 0.14$ ), as well as after the same hypoxic dose ( $P = 0.89$ ). Individual Hbmass responses differed with a large variation within NH and HH (-1.4% - 10.6%). Running performance changed with a moderate effect in the altitude groups (+3.4 - 4.0%  $d = 0.5$ ,  $P < 0.001$ ) and with a small effect in CON (+2.1%,  $d = 0.2$ ,  $P = 0.031$ ), but did not differ between the groups ( $P = 0.27$ ). In cycling performance no changes were detected in any groups ( $d < 0.3$ ,  $P = 0.5$ ). **Discussion** Results indicate that Hbmass changes did not differ between NH and HH with the same hypoxic dose and after 18-days LHTL, as well as did performance indicators. However, individual Hbmass response demonstrated a large variability, which underline the importance of individual evaluation of Hbmass responses to altitude training. **References** Schmidt, W., & Prommer, N. (2008). Effects of various training modalities on blood volume. *Scand J Med Sci Sports*, 18 Suppl 1, 57-69. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates. Contact ana.hauser@baspo.admin.ch

#### LUNG FLUID BALANCE IN HEALTHY HUMANS ACCLIMATING TO HIGH-ALTITUDE

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**Introduction.** The volume of extravascular lung fluid is a function of pulmonary capillary fluid extrusion relative to the rate of fluid removal from the alveoli and pulmonary interstitium. Ascent to high-altitude causes an increase in pulmonary capillary hydrostatic pressure (PCAP) secondary to a hypoxia-mediated constriction of the pulmonary vasculature. In theory, this elevation in PCAP could promote fluid

translocation from the pulmonary vasculature to the interstitial space such that subclinical high altitude pulmonary edema occurs. While rapid, acute exposure to high-altitude (1-3 days) has been shown to increase extravascular lung fluid, whether lung fluid accumulates in humans gradually acclimated to high-altitude remains controversial. Thus, the aim of this study was to assess lung fluid balance before and after gradual acclimation to hypobaric hypoxia in healthy humans. Methods. Lung diffusion capacity for carbon monoxide (DLCO), alveolar-capillary membrane conductance (DmCO), pulmonary-capillary blood volume (Vc), ultrasound lung comets (ULCs) and systolic pulmonary artery pressure (sPAP) were assessed in 12 healthy adults at sea-level and on Day 1 (D1) and Day 9 (D9) after arrival at 5,150 m (Mt. Everest Base Camp, EBC). EBC was reached following an 8-10 day hike at progressively increasing altitudes starting at 2,860 m. Results. From sea-level to EBC, there was an increase in group mean sPAP (D1:  $54 \pm 27\%$ ,  $P = 0.014$ ; D9:  $62 \pm 38\%$ ,  $P < 0.01$ ). Group mean DLCO was unchanged on D1 and D9 at EBC compared to sea-level ( $41.0 \pm 6.9$  vs.  $40.4 \pm 6.3$  vs.  $38.4 \pm 4.8$  ml/min/mmHg). By contrast, DmCO increased from sea-level to D1 ( $85.3 \pm 10.2$  vs.  $91.6 \pm 8.2$  ml/min/mmHg;  $P 0.037$ ), with a further increase in DmCO on D9 at EBC ( $96.0 \pm 8.9$  ml/min/mmHg;  $P = 0.022$  vs. Day 1); Vc was unchanged. Accordingly, there was an increase in the DmCO/Vc ratio from sea-level to D1 and D9 at EBC ( $0.71 \pm 0.18$  vs.  $0.78 \pm 0.25$  vs.  $0.80 \pm 0.22$  ml CO/min/mmHg/ml blood); only the change from sea-level to D9 was significant ( $P = 0.026$ ). There was no change in the number of ULCs from sea-level ( $2 \pm 2$ , range 0-5) to D1 at EBC ( $2 \pm 2$ , range 0-7). There was, however, a slight reduction in ULCs on D9 at EBC vs. at sea-level ( $0.6 \pm 0.7$ , range 0-2;  $P 0.079$ ). Discussion. These data suggest that extravascular lung fluid does not increase in healthy humans gradually acclimated to high-altitude. In fact, the combined findings of an increase in the DmCO/Vc ratio (indicative of improved conductance across the alveolar-capillary barrier) and a reduction in the number of ULCs (an index of extravascular lung fluid) suggest that, if anything, there is a tendency for a reduction in lung fluid volume during acclimation to high-altitude.

### THE EFFECT OF LIVE HIGH TRAIN LOW ALTITUDE EXPOSURE ON THE POST-EXERCISE HEPCIDIN RESPONSE

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Purpose: To investigate the influence of 14 days live high, train low (LHTL) altitude exposure (14 h.d-1, at 3,000 m simulate altitude) on resting and post-exercise hepcidin and iron parameter responses in distance runners. Methods: Ten well-trained distance runners (six males, four females) performed a  $6 \times 1,000$  m interval running session at 90% vVO<sub>2</sub>max in both normoxic (NORM) and simulated hypoxic (3,000 m) conditions (HYP) before, and again on the 11th and 14th day respectively of LHTL. Venous blood samples were collected after 48 h of altitude exposure, as well as before, and 3 h after all experimental trials. Blood samples were analysed for plasma hepcidin, iron, ferritin, transferrin and transferrin saturation (TSAT). Haemoglobin mass (Hbmass) was measured one week before, and two days after altitude exposure via CO rebreathing. Results: LHTL decreased resting hepcidin levels by 2.8 nM [95% CI; -3.7, -5.9] from  $4.0 \pm 1.2$  nM to  $1.2 \pm 0.2$  nM after 48 h ( $p < 0.01$ ). NORM and HYP elevated hepcidin levels by 39.3% [8.0, 79.6] ( $p = 0.02$ ) and 64.5% [16.9, 131.6] ( $p < 0.01$ ) 3 h following interval exercise performed before LHTL. The post-exercise hepcidin response was not different following NORM ( $p = 0.10$ ) and HYP ( $p = 0.37$ ) performed during LHTL. Resting ferritin levels decreased by 27.6% [-37.9, -15.5] and 29.9% [36.2, 22.9] following 11 and 14 days of LHTL, respectively. Finally, LHTL increased Hbmass by 2.2% [1.0, 3.4] ( $p < 0.01$ ). Conclusion: LHTL altitude exposure attenuated resting hepcidin levels but did not alter the magnitude of the post-exercise hepcidin response to normoxic and hypoxic interval exercise.

## Oral presentations

### OP-PM69 Adapted Physical Activity: Mental disabilities

#### SUICIDE PREVENTION THROUGH SPORTS PARTICIPATION. QUANTITATIVE RESEARCH OVERVIEW

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Introduction Suicide is one of the most important problems in the world. It is estimated that the annual suicide rates can rise to 1.5 million by the year 2020. It is known that physical activity and sports can have a great potential in suicide prevention and enhancing mental health effect. In this study we summarize literature results concerning the protective value of physical activity and sports participation against suicidal ideation. Methods The search for relevant articles was done by the PUP Med Database as well by Springer Link. The recent studies were selected from 1994- to 2013. Results In the majority of the studies the findings indicate that involvement in physical activity and sports is associated with lower odds of suicidal ideation and attempts. The results also highlighted that sports participation leads to boosting self-esteem and increasing social support. These findings have led to the assumption that physical activity and involvement in sports have a strong protective value against suicidality. Discussion From this assumption we will go one step further and research if an individualised adapted physical activity and sports program for persons with suicidal ideation has a suicide preventive effect. References Babiss, L., & Gangwisch, J. (2009). Sports participation as a protective factor against depression and suicidal ideation in adolescents as mediated by self-esteem and social support. *J Dev Behav Pediatr*, 30, 376-384 Muller, B., Georgi, K., Schnabel, A., & Schneider, B. (2009). Does sport have a protective effect against suicide? *Epidemiologia e Psichiatria Sociale*, 18 (4), 331-335. Simon, T., Powell, K., & Swann, A. (2004). Involvement in physical activity and risk for nearly lethal suicide attempts. *American Journal of Preventive Medicine*, 27 (4), 310-315. Taliaferro, L., Eisenberg, M., Johnson, K., Nelson, T., & Neumark-Sztainer, D. (2011). Sport participation during adolescence and suicide ideation and attempts. *International Journal of Adolescent Medicine and Health*, 23 (1), 3-10. Taliaferro, L., Rienzo, B., Miller, M., Pigg, R., & Dodd, V. (2008). High school youth and suicide risk: exploring protection afforded through physical activity and sport participation. *J Sch Health*, 78 (10), 545-553. Tao, F., Xu, M., Kim, S., Sun, Y., Su, P., & Huang, K. (2007). Physical activity might not be the protective factor for health risk behaviours and psychopathological symptoms in adolescents. *Journal of Paediatrics and Child Health*, 43, 762-767. Walker, G., & Wendy, B. (2013). Peer Support in adult mental health services: a metasynthesis of qualitative findings. *Psychiatric Rehabilitation Journal*, 36 (1), 28-34. World Health Organization. (1983). *World Health Statistics Annual 1983*. Geneva: World Health Organization. World Health Organization. (2014). *Preventive suicide: a global imperative*. Geneva: WHO Press. Contact herman.vancoppenolle5@gmail.com

**A THEMATIC ANALYSIS OF HIGH PERFORMANCE COACHING ROLES AT THE SPECIAL OLYMPICS WORLD GAMES**

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Coaching athletes preparing for competition at the Special Olympics World Games requires the implementation of a cooperative coaching approach, borne from an athlete-centered philosophy, in which the focus on holistic personal development eclipses winning. Thus central to effective coaching in this context is being able to transform and adapt content knowledge held by the individual coach (coaches' pedagogical content knowledge) for the positive benefit of their athletes. This issue was the subject of a longitudinal study undertaken by Ulster University prior to, during and following the Special Olympics World Games of 2011 staged in Athens. The findings that emerged from this work were extracted using thematic content analysis allowing full immersion in the data, which resulted in the emergence of three prominent themes with subsequent, associated subthemes – using a holistic approach to coaching, building athlete identity and development through sport and capturing the big World Games experience. The findings from this work retain the potential to shape the future coaching and preparation of athletes with intellectual and developmental disabilities for elite competition.

**MIDDLE SCHOOL STUDENTS' ACCEPTANCE ATTITUDE TOWARD THEIR MENTALLY RETARDED PEERS AFTER COOPERATIVE LEARNING AT AN INCLUSIVE PHYSICAL EDUCATION CLASS**

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Introduction For students with mental retardation, teachers and peers' attitude is the critical factor affecting them to successfully involve in an inclusive learning environment. Previous studies have reported that cooperative learning at inclusive physical education classes would promote the social interaction and communication skills of disabled students (Putnam, 1993). However, little research has ever investigated whether cooperative learning strategy can enhance normal students' positive attitude toward their mentally disabled peers. The purpose of the study examined the effect of cooperative learning at an inclusive physical education course on normal students' attitude toward their peers with mental retardation. Methods Thirty-four eighth-grade students (15 boys and 19 girls) were recruited as the participants. All participants accepted an 8-week inclusive physical education program utilizing cooperative learning strategy, 45 minutes per class, two classes a week. The participants were heterogeneously assigned to the contact group and none-contact group. For the contact group, the participants were arranged to learn with five mentally disabled peers, whereas the none-contact group was not. The questionnaire evaluating the attitude toward peers with mental retardation was administered before and after the program. The analysis of covariance was applied to analyze the collected data. Results The result showed that after the "cooperative learning at inclusive physical education", the difference in attitude was not observed between the contact group and none-contact group. Discussion Similar to our finding, Archie and Sherrill (1989) found no significant difference in attitude between the contact group and none-contact group. However, they reported that the members of the contact group responded that the courses were more interesting. Normal students seemed to require a longer duration of inclusive activities to realize how to help their disabled peers and reduce their pressure (Goodwin & Watkinson, 2000). On the other hand, Hutzler (2003) summarized that cooperative learning might fail to induce positive affection without effectively personal interaction between normal and disabled students. Although no significant improvement of attitude was found in this study, future research could apply depth interview to investigate why positive effects do not occur. References Archie, V. W., & Sherrill, C. (1989). *Perceptual and Mot Skill*, 69, 319-322. Goodwin, D. L., & Watkinson, E. J. (2000). *Adapted Physical Activity Q.* 17, 144-160. Hutzler (2003) *QUEST*, 2003, 55, 347-372. Putnam, J.W. (1993). Baltimore, MD : Paul H. Brookes . Contact b6999@hotmail.com

**Oral presentations****OP-PM74 Molecular Biology and Biochemistry: Fatigue****CORTICAL EXCITABILITY, VOLUNTARY ACTIVATION, AND QUADRICEPS STRENGTH CHANGES AFTER MAXIMAL INTENSITY PLYOMETRIC EXERCISE**

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1 PTE (Pécs, Hungary) 2 HUPE (Budapest, Hungary) 3 INEF (A Coruna, Spain) Introduction The stretch-shortening cycle (SSC), in forms of plyometric exercises, is extensively used by practitioners and athletes in performance training. During repetitive SSCs fibers are exposed to high mechanical tension, which contributes to acute fatigue and delayed myofibrillar damage, muscle soreness, and temporary strength loss. Here we investigated the acute and delayed changes in the neuromechanical properties of the quadriceps muscle after maximal intensity SSC exercise, using the conventional electrical stimulation and the transcranial magnetic stimulation (TMS) techniques. Methods Ten non-athlete males performed 150 single-leg hurdle jumps. Maximal voluntary contraction (MVC) force in the quadriceps was determined using a modified leg extension machine attached to a cell force. Voluntary activation was determined using the twitch interpolation technique. Subjects also performed another MVC superimposed with 100-Hz doublet followed by a 10-Hz doublet delivered 4 s apart to determine high and low frequency fatigue, respectively. Electromyography (EMG) was recorded from the quadriceps. Resting motor evoked potentials (MEP) were determined by stimulating the contralateral motor cortex using TMS. Perceived muscle soreness was evaluated using a visual analogue scale. All variables were measured before, immediately (IP), and 24h post-exercise. Results MVC dropped 9% at IP ( $p < 0.005$ ) and fully recovered at 24h. Voluntary activation dropped 6% at IP ( $p < 0.05$ ) and recovered at 24h. Resting single twitch force dropped 23% at IP ( $p < 0.005$ ) and recovered at 24h. Low frequency fatigue was greater (28%,  $p < 0.05$ ) than high frequency fatigue (5%,  $p < 0.05$ ) at IP, however, these values recovered at 24h. Compared to the baseline, MEP amplitudes were 75% smaller at IP but recovered at 24h. Muscle soreness developed at 24h (from 0 mm to 12 mm on the 50 mm scale). Discussion The intensive unilateral SSCs induced acute strength loss in the quadriceps due to neuromuscular fatigue. The reduced voluntary activation and motor cortex excitability indicate central fatigue, an insufficient driving of the motoneurons, however peripheral fatigue (reduced twitch force) seems to contribute more to the acute strength loss. Though mild soreness developed, indicating some muscle damage, neuromuscular performance recovered 24h post-exercise. Contact vaczi@gamma.ttk.pte.hu

## TWO MAXIMAL ISOMETRIC CONTRACTIONS REDUCE MUSCLE DAMAGE AFTER 30 MAXIMAL ECCENTRIC CONTRACTIONS OF CONTRALATERAL ARM

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**Introduction** The magnitude of muscle damage after 30 maximal voluntary eccentric contractions (30MVEC) of the elbow flexors (EF) was attenuated by 2 maximal voluntary isometric contractions (2MVIC) at 20° elbow flexion of the same performed 2 or 4 days earlier [1]. Muscle damage is also less after the second than the first eccentric exercise bout even when the contralateral arm is used for the second bout, which is known as the contralateral repeated bout effect (CL-RBE) [2,3]. However, it is not known whether the protective effect conferred by 2MVIC is transferred to the contralateral arm. The present study investigated the hypothesis that 2MVIC of one arm would confer protective effect on the opposite arm that performed 30MVEC within 4 days. **Methods** Young untrained men ( $21.9 \pm 1.4$  y) were placed into five groups ( $n=13$ /group); one control and four experimental (EXP) groups. The EXP group performed EF 2MVIC at 20° elbow flexion either 1 (1d), 2 (2d), 4 (4d) or 7 days (7d) prior to 5 sets of 6 maximal voluntary isokinetic (30°·s<sup>-1</sup>) eccentric contractions (30MVEC) of the other arm. The control group performed 30MVEC without 2MVIC using the non-dominant arm. Changes in maximal voluntary concentric contraction torque, optimum angle, range of motion, upper arm circumference, plasma creatine kinase activity and myoglobin concentration, muscle soreness and B-mode ultrasound echo intensity for the exercised muscles before, immediately after and 1-5 days after 30MVEC were compared amongst the groups by a two-way repeated measures ANOVA. **Results** No significant changes in any dependent variables were evident after 2MVIC. All dependent variables showed significant ( $P<0.05$ ) changes after 30MVEC, but the changes were smaller ( $P<0.05$ ) for the 1d and 2d groups compared with the control group, without significant differences between the 1d and 2d groups. No significant differences in the changes were found amongst the 4d, 7d and control groups, except for muscle soreness showing significantly ( $P<0.05$ ) smaller changes for the 4d group than other groups. **Discussion** These results partially supported the hypothesis, since the contralateral protective effect conferred by 2MVIC lasted for 2 not 4 days. The magnitude of the protective effect by 2MVIC found in the present study was smaller by approximately 20% than that found in the previous study [1] in which the same arm was used for 2MVIC and 30MVEC. These results suggest that some neural adaptations are associated with the CL-RBE. **References** 1) Chen et al. (2013) *Eur J Appl Physiol*, 113, 1545-54. 2) Starbuck & Eston (2012) *Eur J Appl Physiol*, 112, 1005-13. 3) Newton et al. (2013) *J Sci Med Sport*, 16, 166-71. Contact: k.nosaka@ecu.edu.au

## EFFECT OF NEUROMUSCULAR ELECTRICAL STIMULATION FREQUENCY ON VOLUNTARY NEURAL DRIVE

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**INTRODUCTION** The force loss induced by neuromuscular electrical stimulation (ES) can be related to acute changes at muscle level, particularly when using high ES frequencies [1]. However it has been suggested that with such frequencies (>80Hz) the decrease of maximal voluntary contraction (MVC) after ES protocol can also be attributed to neural mechanisms [2]. The aim of the study was to analyze the impact of ES protocols with low to high frequencies on voluntary neural drive, assessed by H- and V-wave responses evoked during MVC. As the electrically induced torque vary according to the ES frequency [3], the same muscular activity was assessed by matching the torque time integral (TTI) across ES protocols. **METHOD** Eight healthy subjects performed 3 testing sessions with 3 ES protocols (randomly assigned) combining pulse width of 1ms with ES frequencies of 20, 60 and 100Hz. Triceps surae muscle was stimulated by two rectangular electrodes placed on calf muscles at ES intensity evoking 20% of MVC. Plantar flexion torque and electromyographic activity of soleus muscle were recorded continuously. During the first session, 40 stimulation trains (6s on/ 6s off) were delivered, while for the following sessions the number of trains was adjusted to match TTI obtained in the first session. Before and after ES protocol, subjects performed MVC and electrical stimulation of the posterior tibial nerve, evoking H- or M-wave responses, was delivered on the torque plateau. The following parameters were analyzed: MVC torque, H reflex (Hs), M wave (Ms) and V wave amplitudes. **RESULTS** For the similar TTI (5756.4  $\pm$  277.6 Nm.s), the number of contractions performed by subjects was significantly different between ES protocols (from 36.8 $\pm$ 1.6 at 20Hz to 44.1 $\pm$ 2.5 at 100Hz). After ES protocol, the MVC decreased by 9.9 $\pm$ 3%, 10.9 $\pm$ 3% and 14.5 $\pm$ 3% with 20Hz, 60Hz and 100Hz respectively. This decrease was greater for 100Hz than for 20Hz protocol ( $P<0.05$ ). Hs/Ms decreased by 31.2 $\pm$ 4.4 % after 100Hz ( $P=0.01$ ) while V/Ms decreased after 60Hz and 100 Hz protocols by ~31% ( $P=0.05$ ). **DISCUSSION** For ES protocols with similar TTI, a greater MVC loss was observed after the 100Hz protocol. This greatest force loss was accompanied by a reduction in both spinal excitability and cortical descending drive evidenced by a decrease in H- and V-wave amplitudes respectively. The 60Hz protocol altered only the cortical descending drive. It can be concluded that for the same pulse width, the higher the ES frequency used, the greater the decrease in voluntary neural drive that involve mechanisms located at cortical and spinal levels. **REFERENCES** (1) Gregory CM & al., *Muscle Nerve* 2007; 35:504-7. (2) Papiadaniou M & al., *Muscle Nerve* 2014; 50:604-7. (3) Neyroud D & al., *J Appl Physiol* 2014; 116(10):1281-9.

## INTERMITTENT THETA BURST OVER M1 CAN IMPROVE THE PEAK POWER IN A WINGATE TEST AND SUPPRESS THE SUBSEQUENT SUPRASPINAL FATIGUE

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Despite the fact that repetitive transcranial magnetic stimulation (rTMS) is known to improve performances in patients suffering from motor neuronal afflictions, its possible effect on motor performance enhancement in healthy subjects during a specific sport task hasn't been tested yet. We hypothesised that intermittent theta burst (iTBS) induces a higher power output and a greater resistance to supraspinal fatigue during a popular sport specific test, the Wingate Anaerobic Test (WAnT). Ten subjects participated in two randomised experiments separated by at least 2 days, consisting of a WAnT 5 minutes after either an iTBS or a SHAM treatment. Voluntary activation (VA) of the right vastus lateralis was estimated with TMS (VATMS) over the quadriceps motor cortex area and also with peripheral nerve stimulation (VAPNS) of the femoral nerve, before and after the WAnT. Muscle twitches size at rest and motor evoked potentials (MEPs) given at 10% maximal voluntary contraction (MVC) were also measured. Tests were applied on WAnT results and 2 ways ANOVA with repeated measures on VA estimations, muscle twitch size at rest and MEPs. The iTBS treatment increased the peak power during the WAnT (961.1 $\pm$ 51.3 W for SHAM and 970.7 $\pm$ 51.1 W for iTBS,  $p=0.037$ ) and suppressed the reduction of VATMS following the WAnT compared to the SHAM treatment (time effect:  $p=0.001$ , time \* treatment effect  $p=0.001$ ), but not of VAPNS. There was no difference of decrease of the size of the muscle twitches at rest between the treatments, and no difference of MEP size pre and post WAnT and between the treatments. We have shown for the first time that iTBS applied 5 minute before a WAnT can enhance the peak power and suppress

the subsequent supraspinal fatigue. The use of iTBS in order to improve sport performances and to study mechanisms of supraspinal fatigue may be warranted.

### HETEROGENEOUS MUSCLE ACTIVITY DURING ISOMETRIC CONTRACTION – A VE-PC MRI STUDY

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**Background** During submaximal contraction, skeletal muscles are not uniformly activated. Rather task groups of motor units are recruited in dependency of the specific demands of movements. While most commonly used to study such recruitment patterns, EMG is limited by its low spatial resolution, small area of detection, and inability to resolve along the depth direction. An alternative approach is represented by a dynamic (velocity-encoded phase-contrast, VE-PC) MRI technique, which provides 3D information about the displacement of tissues and facilitates measurements with great resolution over large areas of interest. However, the congruence of EMG and VE-PC-based measures of muscle activity has not been established yet. **Aims** (1) To determine the correlation of EMG and VE-PC data obtained during submaximal, isometric contraction. (2) To use VE-PC MRI for an in-depth analysis of the contractile behavior of the human triceps surae complex. **Methods** Ten healthy subjects (3 females,  $27.0 \pm 6.2$  yrs,  $169.6 \pm 11.8$  cm,  $69.3 \pm 13.7$  kg) were tested for isometric plantarflexion MVC strength. Subsequently, 10 axial-plane VE-PC MRI scans (distributed evenly across the triceps surae) were obtained while subjects performed the ~70 submaximal contractions (40% MVC) required for image acquisition. EMG data from the soleus (SOL) and gastrocnemius muscles (GM, GL) were then obtained under identical experimental conditions. Integrated EMG and VE-PC data were averaged over all contraction-relaxation cycles and correlated against each other. To assess the regional heterogeneity in muscle activity, VE-PC data were statistically compared both between and within slices, and visualized as 3D color maps of muscle movement. **Results** Correlational analyses demonstrated good agreement between EMG and VE-PC-based measures of muscle activity in the entire triceps surae complex (GM:  $r = 0.87$ ; GL:  $r = 0.88$ ; SOL:  $r = 0.84$ ;  $p < 0.001$ ). Comparison of VE-PC data across slices revealed substantial differences between caudocranial positions. In the GM and GL, muscle tissue movements were significantly larger in the center than in the proximal ( $U = 7.5$ ,  $p = 0.006$ ) and distal ( $U = 8.0$ ,  $p = 0.030$ ) regions, respectively. Heterogeneity was also observed within slices, with "hot" regions evidencing tissue displacements that were 3-6 times larger than those seen in "cold" regions. **Conclusions** In spite of the different underlying physiological principles, VE-PC MRI demonstrates good agreement with EMG data and may be used to study muscle activity with high spatial resolution and in large areas of interest. Application to the human plantarflexor muscles revealed startling heterogeneity of contraction-associated tissue movements.

## Oral presentations

### OP-SH13 Sociology/Psychology (Talent identification)

#### IDENTIFYING TALENT: THE CASE OF THE SWEDISH FOOTBALL ASSOCIATION

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**Introduction** The purpose of this paper is to explore how football coaches select 15-year old players to their regional teams. Drawing on Bourdieu, MacCormick and Wenger's work we challenge the common-sense assumption that talent identification is an objective process. Using this broad set of theoretical perspectives, there is also an ambition to refine the sociological theorization of talent identification (e.g. Christensen, 2009). **Method** The analysis is based upon interviews with 19 coaches that participate in the process of identifying the most talented players in their regional district. The three football districts that participate in the study are chosen with regard of size, geographical location and previous results in national tournaments. This case study approach, is well-suited for answering questions of social process and designed for the study of contemporary social phenomenon in context, especially when it is not possible to clearly distinguish the context and the phenomenon (Yin 2009). **Results** Our data indicated that these coaches identified talent in four interrelated ways. First, the coaches' uses classification schemes in order to objectify and legitimize the identification process, e.g. previous results, physique, training background, technical skills, attitude, and social adaptability. Secondly, coaches use their visual experience and practical sense in order to define talent. Thirdly, classification and practical sense is closely related to narratives of elite football and previous successful identification processes. Fourthly, the identification process takes place within a community of practice. The communicative and social interaction between the coaches and their shared passion for football structure their learning processes towards a similar understanding of how to see and find talent. **Discussion** Our results show that talent is a social construction, which is expressed through the experience, knowledge and taste of the coaches that uphold the authority to demarcate talent from non-talent. **References** Bourdieu, Pierre (1998). *Practical reason*. Cambridge: Polity. Christensen, Mette Krogh (2009). *An Eye for Talent: Talent Identification and Practical Sense of Top-level Soccer Coaches*. *Sociology of Sport Journal*, 26, 365–382 McCormick, L. (2015). *Performing Civility: International Competitions in Classical Music*. New York: Cambridge University Press (in print). Wenger, Etienne (1998). *Communities of practice: learning, meaning and identity*. New York: Cambridge University Press. Yin, R. K. (2009). *Case study research: design and methods*. Los Angeles: Sage Publications.

#### TALENT SELECTION IN SWEDISH YOUTH FOOTBALL: THE RELATIVE AGE EFFECT AND PARENTAL SUPPORT

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**Introduction** This study reports empirical data from an ongoing project, investigating talent development in football. The purpose is to examine predictors that impact on 14-year old football players' possibilities to enter and proceed through the Swedish Football Association's talent development system. Drawing on deliberate practice and deliberate play (Côté, Baker & Abernethy, 2003), the relative age effect (RAE) (Romann & Fuchloser, 2011) and sporting habitus (Bourdieu, 2010) we focus on football training in clubs and school, training time in football and other sports, birth dates and parental support. **Method** The analysis is based upon questionnaires from one large and one medium district. The study included 166 boys and 117 girls who at the age of 14 participated in the first selection camp at each district. They were then followed until their last selection the year thereafter, in which 16 boys and 16 girls were selected to represent the

district in a national elite camp. Result The results show that 67% of the boys and girls were born in the first six months, RAE then increased for boys, with 83% in the last selection being born the first six months girls RAE were constant. Boys practiced more football both in and outside their club, 61% of the boys and 40% of the girls reaching the last selection practiced 7 hours or more in their club. 33% of the boys and 8% of the girls practiced 5 or more hours on their own. For girls selected, on each level parental support was stronger than for not selected girls, for both boys and girls who were selected for the final district team parental support was almost twice as big in terms of presence at games and practice. The parents of the players who were selected had to a great extent a competitive sport background. Discussion The results show that RAE is a threshold for entering the system and then increase for boys. The 14-year old football players' proceeding through to the district team seem to be related to training hours, especially for boys, and parental support, especially for girls. These results suggest a need to further explore how these factors shape the selection processes for boys and girls and the recruitment of the final 16 players in the district team References Bourdieu, P. (2010). *Distinction: A Social Critique of the Judgment of Taste*. London: Routledge Côté, J., Baker, J. & Abernethy, B. (2003). From play to practice: a developmental framework for the acquisition of expertise in team sport. In Starker, J. & Ericsson, A.K. (Eds.) *Recent advances in research on sport expertise*. Champaign, IL: Human Kinetics Romann, M., & Fuchloser, J. (2013). Relative age effects in Swiss junior soccer and their relationship with playing position. *European Journal of Sport Science*, 4, 356-363.

### **PARTICIPATION IN NON-ELITE SPORT IN EARLY ADULTHOOD: THE IMPACT OF ATHLETIC ABILITY IN CHILDHOOD AND ADOLESCENCE**

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Introduction Understandings of, explanations to, and predictors of adult participation in organized sport, on the one hand, and expert performances in organized sport as adults on the other hand have received a lot of attention as separate entities by scholars in the areas of sport participation and sport expertise alike. Although scholars in both fields share an interest in tracing explanatory factors and predictors, it is evident that sport participation research has not investigated the impact of factors that are in focus in sport expertise research and vice versa. Thus, in this paper we aim to explore relationships between sport performance during childhood and adolescence and participation in sport in adulthood. Methods Data were derived from Web-based questionnaires completed by university students between 2005 and 2012. In total, 572 students (290 men and 282 women) completed the questionnaires. These students were at the beginning of their studies in sports science (n=357) and physical education teacher education (n=215). The questionnaire gathered information about the following topics: • Biographical data: date of birth; • Sport debut: age they started to participate in organized club sports; • Sport performance: self-estimated sporting skills and participation in regional talent groups during childhood and adolescence. • Sport involvement: previous and present involvement in organized club sports; Results Results from questionnaires reveal that early sport debut and date of birth positively correlate to strong sport performances during childhood and being selected for talent groups. These variables, in turn, are positively correlated to strong sport performances during adolescence and being selected for talent groups. Strong sport performances during adolescence do not correlate to expert performance as adults. However, strong sport performances during adolescence are positively correlated to sports club membership as adults. Discussion These results suggest a need to further explore how factors found to be important for elite sport practice and expert performance, also influence non-elite sport participation in adulthood. Our findings suggest that talent development system selecting children and youth to develop their abilities and to become elite athletes, not only develops potential elite athletes but also shapes the larger recruitment of adults to sport at non-elite levels and participation in general exercise activities.

### **A SOCIAL LEARNING PERSPECTIVE ON SUCCESSFUL TALENT DEVELOPMENT ENVIRONMENTS: A QUALITATIVE STUDY OF TWO EXCEPTIONAL HANDBALL CLUBS IN SCANDINAVIA**

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Introduction The social learning perspective is rarely used for the study of talent development in sport, although it is broadly known in the domain of education. This study examines the ways in which social practice underpins talent development in team sport in two exceptional successful talent development environments in Scandinavia: (1) The way in which communities of practice are connected, (2) what characterises talents' movements across communities of practice within the club, and (3) what characterises the interactions between talents, senior players and coaches. Methods The study was a case study of two successful talent development environments in Scandinavian handball. The selection of two most similar clubs was based on three criteria: (1) demonstrated sustained and consistent ability to create senior elite athletes out of their talented juniors; (2) were recognised as a great environment for athletic development by the national federation; and (3) were accessible and willing to share details of their day-to-day practices with the principal researcher. The study was based on fieldwork (participant observation and qualitative interviews): 150 and 100 hours of participant observation in each environment, and 17 and nine interviews with players, coaches and managers. The analysis proceeded in three stages: open coding, organising data into topics (e.g. social processes, organisational set-up) and focused analysis and interpretation of discrete parts. The social theory of learning (Wenger, 1998) informed the data analysis. Results The two environments were characterised by (1) a constellation of several interconnected communities of practice (CoPs). The boundary encounters, overlaps and peripheries were important 'windows' and 'places' for the talents' learning and development. (2) Opportunities for talents to participate and engage in various CoPs. (3) Individually adjusted feedback from coach to player combined with communication between the talents and experienced players and not only coach instructions, and (4) senior elite players' engaging behaviours in regard to newcomers and thereby legitimate peripheral participation opportunities for talented players. The coaches were the key to coordinate the interconnected practices and social interactions between the 'youth CoP' and 'senior elite CoP'. And the senior elite players' behaviour had great influence on the talents learning within the club. Discussion The interaction and coordination between and/or across the CoPs and the proximal role modelling is discussed as a crucial contributing reason to successful talent development. Wenger, E. (1998). *Communities of practice. Learning Meaning, and identity*. NY: Cambridge University Press. Contact lkstorm@health.sdu.dk

## PARENTAL CREATED MOTIVATIONAL CLIMATE AND WELL-BEING AMONG YOUTH ELITE ATHLETES

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Parents have a large impact on children's psychological development and socializing into sports. Parental support, praise, and compliments have been found to boost children's perception of their skills, satisfaction, and positively influence children's interest in sport activities (Bois et al., 2005). Another aspect of support, praise, and compliments is that parents socialize their achievement perceptions to their child through their own beliefs about what is important and what leads to success in sport, by the use of different reward systems (White et al., 2004). Support, praise, and compliments can be seen as innocent statements by a parent, however, such statements can create a parent-initiated motivational climate that focus on results and outcome, which can have implications for the child's motivation and well-being later on. The aim of this study was to explore how the perceived parent-initiated motivational climate and athletes' perceived sport competence is related adolescent athletes' well-being and depression/anxiety. Methods: 259 athletes (alpine skiers, biathletes, cross-country skiers) from 16 to 20 years of age participated in this cross-sectional study. Athletes' perceptions of the climate initiated by their parents was assessed with the PIMCQ-2 and perceived sport competence was assessed with a subscale from the BNSSS. The athletes' psychological well-being was measured with the GHQ-12. Results: The results indicate that male athletes experience higher levels of well-being and lower levels of depression/anxiety compared to female athletes. In the first hierarchical regression model with well-being as outcome variable, the overall model explained 33 % of the variance. Gender, a mother-initiated learning/enjoyment climate, and perceived sport competence were positive predictors of well-being. The second hierarchical regression model with depression/anxiety as outcome variable, explained 21 % of the variance. Mother-initiated learning/enjoyment climate and a father-initiated worry-conducive climate positively predicted depression/anxiety, while perceived sport competence negatively predicted depression/anxiety. Conclusions: One result that stands out in the study is that mother-initiated learning/enjoyment climate positively predicted depression/anxiety. This is a result which is not in line with earlier results or theory. Experience of perceived competence is an important protector from feelings of depression and/or anxiety, and has an important role in children's experience of well-being. References: Bois et al., (2005). *J Appl Spo Psy* 17: 273–289 White et al., (2004) *Scand J Med Sci Spo* 14: 57-66

## SWEDISH JUNIOR ATHLETES' PERSONAL PROFILES IN RELATION TO THE DYNAMICS OF ADJUSTMENT IN THE JUNIOR-TO-SENIOR TRANSITION

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According to previous research, the junior-to-senior transition (JST) is decisive for athletes who want to reach the elite/professional sport level, it lasts for 2-4 years, and is known for its high dropout rate. The longitudinal study of the junior-to-senior transition process in Swedish club-based athletes conducted by the authors involved several lines of data analysis with this presentation focusing on the dynamics of athletes' junior-to-senior transition adjustment in relation to their personal characteristics. The study had five measurements conducted every six months using several instruments; these instruments measured the athletes' level of athletic identity, task- and ego orientation, self-esteem and adjustment in the transition process. The latent profile analysis identified three profiles (based on athletes personal characteristics; BIC = 771.11; entropy = 0.87; Parametric Bootstrapped likelihood ratio test = -356.07,  $p < 0.001$ ). In the profile-1, athletes (34 males and 11 females) were characterized by high athletic identity, self-esteem, task orientation, and the JST motivation; they also had moderately high ego orientation. These athletes perceived to be 72 % adjusted at the first measurement, had a positive progression through the transition process, and at the fifth measurement perceived to be 83 % adjusted at the senior level. In the profile-2, athletes (30 males and 7 females) perceived themselves to have high self-esteem and the JST motivation, relatively high athletic identity and task orientation complemented by moderate ego orientation. They perceived themselves to be 66 % adjusted at the first measurement, had a positive progression through the transition process, and at the fifth measurement perceived themselves to be 73% adjusted. In the profile-3 athletes (9 males and 9 females) reported high self-esteem, relatively high task orientation, as well as moderate athletic identity, ego orientation and the JST motivation. These athletes perceived to be 62 % adjusted at the first measurement, had almost no progression through the transition process, and at the fifth measurement perceived themselves to be 64 % adjusted. These findings supported our hypothesis that athletes with different profiles of personal characteristics follow different pathways through the JST process. The JST pathways are going to be explored more in detail with the aim to understand transition variables contributing to the dynamics of perceived adjustment. Further this knowledge can be used in assisting athletes in the JST.

## Oral presentations

### OP-SH14 Sociology: Sport media

#### GREENING JOURNALISM EDUCATION

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Introduction: This paper intends to reflect on how journalism education can respond to ecological crisis in times of hyper-consumerism. Sports have real and serious environmental consequences. Maxwell and Miller has demonstrated the many ways media contribute to environmental degradation while, at the same time contributing to constructing a vision of new communication technologies as environmentally cost free. However, modern sports and media are entangled in a web of hyper-consumerism and commodification. For instance, when events such as the World Cup, the Euros, and the Champions' League are planned and executed, they leave ruinous ecological costs due to travel and use of electronics as their permanent legacies. As Maxwell and Miller correctly states in "Greening Media Education", this presents media and journalism educations with some serious ethical and pedagogical questions to ponder (Maxwell & Miller, 2015). Methods: The paper draws on existing journalism studies syllabus at Norwegian Journalism Schools to reflect on current teaching on environmental issues. It further draws on existing research on values and norms among journalists and students of journalism in Norway to analyze the role and social responsibility of journalism education (Krøvel, 2015, Forthcoming). Finally, the paper is experienced based in the sense that it makes use of experience gained over seven years of teaching sports journalism to journalism students.

Discussion We find that very little attention is paid to environmental issues in Norwegian journalism education. What is offered, is typically given in courses for students with a "special interest" in environmental issues. Environmental degradation due to sports and mega events, for instance, is hardly mentioned during courses in sports journalism. The compartmentalization of different subjects into sections resembles the differentiation found in newspapers between sections. The paper ends with a discussion employing the concept of a "total view" to discuss "greening journalism education". According to Næss, we should not expect much from specialists. Instead, what is needed is "enlightened generalists" willing to develop "total views" in contrast to the on-going process of ever-greater specialization and reductionism (Næss & Rothenberg, 1989).

### **ATTITUDES TO ENVIRONMENTAL SUSTAINABILITY OF FOOTBALL FANS IN ENGLAND: A CASE STUDY**

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When the issue of sustainability is discussed by English football fans, it tends to be financial and social sustainability that tops the agenda. There are football fans who are politically and culturally aware and have set up clubs and supporters' trusts that they hope will reflect their ideals, but these rarely have anything to do with environmental concerns. The hope for many is that clubs will adopt policies that are inclusive and do not involve pricing people out of attending football matches. There are, however, some examples of environmentally sustainable stadiums in England – Forest Green Rovers' New Lawn is one such example, while Dartford's Princes Park is another. The paper will look at trends in environmentally sustainable stadium design. It will also examine how attitudes of fans and the media to the environmental policies of Forest Green Rovers in particular (the stadium is run on "clean" energy and there is a ban on meat products as these are considered not environmentally friendly) have impacted on the issue of environmental sustainability in English football. Key-words: Media, sustainability, football fandom

### **WHERE THE GRASS IS ALWAYS GREENER': FOOTBALL FANS TALKING - AND NOT TALKING - ABOUT ENVIRONMENTAL ISSUES**

Sandvoss, C.

*Sport Dep*

Football fandom constitutes an important part of the contemporary public sphere, (Sandvoss 2003, 2011, Ruddock 2007) in particular within the distinct spaces of debate through fans' enunciative productivity in online fan fora and on terraces themselves. However, while being an important space of political debate and civic participation, football fandom is no neutral medium of political discourse but shapes debates in two important respects. Firstly, debates among scholars of political communication and football fans follow curiously synchronous lines. While the first group has lamented the popularization and thus trivialisation of politics in which sport has played an important role, the latter has objected to the politicisation of sport. Secondly, participation in the public sphere through the prism of the fandom profoundly shapes the substance and form of political discourses among fans. This paper explores debates about the environmental impact of football and football fandom on football fan fora in two of Europe's top five football markets with different political cultures and propensities to environmentalism: England and German. Studying five online fora in each of these markets, through a mixed methods approach including quantitative content analysis, in-depth interviews and a CASI online survey this paper explores the interplay between discourses of environmentalism, political beliefs and fandom, suggesting that recent work on fan activism (cf. Jenkins 2013) overstates the politically progressive potential of participatory culture in traditional spaces of popular culture such as football.

### **FLATSCREENING FOOTBALL: ECOLOGICAL PERSPECTIVES ON ELECTRONIC SPECTATORSHIP**

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Along with the Olympics, major football championships provide important occasions for the electronics industry to market newer, bigger and supposedly better gadgets for screen-based football spectatorship. They are also useful pretexts for digital service providers to persuade their customers to expand bandwidth and cloud capacities. Both of these phenomena add to the ecological footprint of any given international sporting event, by generating more waste hardware, on the one hand, and requiring more waste energy, on the other. This visually-led presentation demonstrates an eco-ethical approach to electronic football spectatorship. It combines statistics on hardware and energy flows with new materialist theory to frame an environmentalist interrogation of a world sport system which is deeply enmeshed in what Richard Giulianotti (2007) has called «the intensified international flows of labour, capital, images and information». Contact email: nina.vestberg@ntnu.no

### **MEDIA COVERAGE OF THE OLYMPIC GAMES – LONDON 2012 IN BRAZIL: A COMPARISON BETWEEN SOCCER AND THE MAIN BRAZILIAN OLYMPIC SPORTS**

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The objective of this research is to demonstrate that, in times of mega events, the Brazilian media behavior is much friendlier to entertainment news and spectacle than restricted to sports apparel. In Brazil, the daily sports media is not used to report facts concerning volleyball, judo and sailing. In time of Olympics Games, as these modalities always get medals for Brazil, the media is required to cover the volleyball, the judo and the sailing competitions. For this, we compare these three sports, which are those in which Brazil has won more medals in Olympic history, with coverage of soccer. Soccer had much success in terms of winning medals. THEORETICAL BACKGROUND The symbolic construction of the sports press is made of professional athletes, especially in time of Olympics, it seeks to turn these athletes into heroes, conquerors made of unusual representative of what the company wants to achieve. The major sports event and athletes are seen as elements of consumption, as a culture, entertainment and spectacle (Van Bottenburg, 2001). One of the strands used by the media to build, in its speech, of legitimizing the sport as spectacle, is the development of the athlete's sporting image, elevation to celebrity status (Amidon, 2012). Guy Debord (1997) calls it "the spectacle society" and Alan Bryman (2004) says that it is the "disneyization of society". METHODOLOGY For 76 days, from July 24 until October 07, 2012, 3 major print media outlets were followed in Brazil - three daily newspapers of national circulation. We selected all the materials that was related to the 2012 Olympics, in general, and also



about soccer, volleyball, judo and sailing. The subjects were classified into five broad categories: a) sports apparel; b) economic fact; c) behavioral fact; d) real show; and, e) political fact and/or national identity. For this classification, we used the method of content analysis developed by Lawrence Bardin. RESULTS AND DISCUSSION During the period considered, 4618 were obtained news about the Olympics in all its aspects. Of this total, only 686 (14.85% of total) had as volleyball, judo and sailing with main subject. According to the news about these three sports, 237 (34.55%) were classified as behavioral fact such as how the athletes lives, their parents's reaction during the games etc. On the other hand, these three sports won 51.85% medals of Brazil's entire history of the Olympics Games. By the way, soccer won only 6.45% medals in this competition. The news is produced more to be sold and less to inform society. It is "the spectacle society" (Debord, 1997) and reveals to us that we are living the "disneyization of society (Alan Bryman, 2004). REFERENCES Amidon, S. (2012). Something like the gods: a cultural history of the athlete from Achilles to LeBron. New York: Rodale/Macmillan Bryman, A. (2004). The Disneyization of Society. London: Sage. Debord, G. (1997). The spectacle society. Rio de Janeiro: Contraponto. Van Bottenburg, M. (2001). Global games. Urbana: University of Illinois Press.

## Oral presentations

### OP-PM37 Training & Testing: Endurance I

#### EFFECT OF SOCIO-GEOGRAPHICAL VARIABLES ON SEASONAL PERIODISATION OF TRAINING LOAD IN AUSTRALIAN AND EUROPEAN PROFESSIONAL CYCLISTS

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1: ECU (Perth, Australia), 2: AIS (Canberra, Australia)

**Introduction** The cycling season is divided in three periods: offseason (OFF), preparation (PREP) and competition (COMP) (2). Many variables have been suggested to influence periodization strategies (1). Professional cyclists native of the Southern hemisphere usually spend their OFF and PREP phases on home soil, avoiding the winter in the northern hemisphere. The effect of this socio-geographical variable on training periodization and performance is not well known. The aim of this study was to compare seasonal training volumes and best power outputs (PO) data from professional cyclists who are natives of Southern (SH) and Northern (NH) hemispheres. **Methods** Training and racing of 12 professional cyclists (n: 6 SH; 6 NH) was monitored for 12 months using cycling power meters (SRM). Three seasonal phases were defined: OFF (Oct), PREP (Nov to Jan) and COMP (Feb to Sep). Monthly distance, best PO for 5 sec, 5 min and 20 min were evaluated for both groups. The dependent variables were compared using a two-way ANOVA with repeated measures over time (2 hemispheres x 3 training phases). When a significant F-value was observed, Fisher's LSD test was applied. Critical level of significance was established at  $P < 0.05$ . Results are presented as means  $\pm$  SD. **Results** The seasonal training volume was similar for SH and NH (28774 $\pm$ 4660 and 28648 $\pm$ 2088 km). Monthly distances ridden in PREP and COMP phases were not different in SH (PREP: 2585 $\pm$ 462 and COMP: 2514 $\pm$ 708 km), but significantly different in NH (PREP: 1996 $\pm$ 692 and COMP: 2744 $\pm$ 477 km;  $P < 0.0001$ ). The best 5s PO was significantly different only in NH cyclists between OFF and COMP (OFF: 14.5 $\pm$ 3.3 and COMP: 16.9 $\pm$ 2.1 W/kg;  $P = 0.009$ ). The best 5m PO in PREP and COMP were not different in SH (PREP: 6.3 $\pm$ 0.5 and COMP: 6.2 $\pm$ 0.4 W/kg), but they were significantly different in NH (PREP: 5.7 $\pm$ 0.7 and COMP: 6.5 $\pm$ 0.5 W/kg;  $P < 0.001$ ). Similarly, the best 20m PO in PREP and COMP were not different in SH (PREP: 5.2 $\pm$ 0.4 and COMP: 5.2 $\pm$ 0.8 W/kg), but they were significantly different in NH (PREP: 5.1 $\pm$ 0.7 and COMP: 5.7 $\pm$ 0.8 W/kg;  $P = 0.01$ ). **Discussion** Professional cyclists from the southern hemisphere generally sustain similar training volumes during PREP and COMP whereas their counterparts from the northern hemisphere tend to train less during PREP compared to COMP. In NH cyclists the best power output recorded for duration ranging between 5 sec and 20 min are lower in the OFF or PREP phases when compared to the COMP phase. **In conclusion**, this study highlighted that the seasonal periodization of both volume and intensity differ between cyclists from the SH and NH. **References** 1. Kiely, J. *Int J Sports Physiol Perform* 7: 242-250, 2012. 2. Pinot, J and Grappe, F. *J Sports Sci*: 1-8, 2014. Contact Paolo Menaspä, p.menaspa@ecu.edu.au

#### CADENCES EFFECT ON ENERGY EFFICIENCY DURING SUBMAXIMAL INTENSITY IN ERGOMETER KAYAKING

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**Introduction:** Research focusing on physiological performance factors in long duration Flatwater Kayaking is limited, even though long distance kayaking in the form of Marathon kayaking is part of the international Kayak World Cups with more than 87 countries participating. The ability to be energy efficient and economize with stored energy resources to avoid fatigue can be considered a vital part of long distance kayaking. This study focus on energy efficiency for three predetermined cadences and the freely chosen cadence during ergometer kayaking. Based on previous studies on optimal cadences in cycling. It was hypothesized that the freely choosing paddling cadence would be less efficient compared to the most efficient of the three predetermined cadences. **Methods:** 11 male elite Flatwater Kayaking paddlers (age: 19  $\pm$  3, weight: 80  $\pm$  9kg, height: 1.83  $\pm$  0.05m) completed two tests on a Dansprint ergometer. A VO<sub>2</sub>max test was followed by a cadence test, at submaximal intensity of 60% VO<sub>2</sub>max for cadences 65-, 75-, 90 SPM and the freely chosen cadence while measuring energy expenditures. **Results:** A pairwise comparison showed a statistical significant difference between gross efficiency for 65-75 SPM ( $P = 0.0000004$ ) and 65-90 SPM ( $P = 0.016$ ) where 65 SPM was the least efficient. The individual most efficient pre-determined cadence of the three cadences and the freely chosen cadence for each subject showed no statistically significant difference for gross efficiency ( $P = 0.56$ ). **Discussion:** The difference between the cadence 65 SPM and cadences at 75- and 90 SPM could be explained by the efficiency related to contraction velocities of muscle fiber types where low and high cadences has been shown to be less efficient theorizing that 65 SPM in kayaking is primarily driven by the contraction of the less efficient type II fibers. Support to the hypothesis that the freely chosen cadence is not the most energy efficient was not found, but another paradox to which subjects paddling at a freely chosen cadence closely resembling the predetermined cadence 65 SPM, had large disparities in VO<sub>2</sub> and gross efficiency. A possible explanation could be that following a predetermined cadence, leads to an increase in muscle coordination and therefore a higher VO<sub>2</sub> consumption. **References:** Anslay Les. & Patrick Cangle. Determinants of optimal cadence during cycling - *European Journal of Sport Science*. 2009. Ettema Gertjan & Havard Wuttudal Loras. Efficiency in cycling: A review- *Euro J Appl Physiol* 106:1 to 14. 2009. Hansen Ernst A. & Gerald Smith. Factors Affecting Cadence Choice During Submaximal Cycling and Cadence Influence on Performance - *International Journal of Sports Physiology and Performance*, 4, 3-17. 2009. McDonnell L. K., A. Hume P., Nolte V. A deterministic model based on evidence for the

associations between kinematic variables and sprint kayak performance - Sports Biomechanics 12. 2013. 205–220. Contact Study group: 15gr639@hst.aau.dk and supervisor: cgo@m-tech.aau.dk

### CHRONIC EFFECTS OF SUPERIMPOSED ELECTROMYOSTIMULATION DURING CYCLING ON AEROBIC AND ANAEROBIC CAPACITY

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**Introduction** Electromyostimulation (E) might be a useful tool to intensify endurance training without performing high external workloads. Therefore, the purpose of the present study was to investigate for the first time the chronic effects of superimposed E during cycling on aerobic and anaerobic capacity as well as on markers of muscle damage. **Methods** 21 male subjects (age: 23.4±4.9, mass: 76.3±9.4 kg, rel. VO<sub>2</sub>peak: 57±4.5 ml min<sup>-1</sup> kg<sup>-1</sup>) were randomly assigned to either a cycling (C) or cycling with superimposed E (C+E) intervention group. They performed 14 training sessions over a four-week period. Depending on the group, each training session consisted of 60 min cycling at 60% PPO with or without superimposed E. Before and after training phase, subjects completed 1) a step test to determine VO<sub>2</sub>peak, peak power output (PPOST), power at 2 mmol l<sup>-1</sup> blood lactate (PL<sub>2</sub>), onset of blood lactate accumulation (OBLA), and maximal fat oxidation rate (Fatmax); 2) a 30 sec Wingate anaerobic test to determine PPOW, mean power output (MPOW), and maximal rate of blood lactate accumulation (dLa dtmax-1); 3) a 20-min time-trial to determine MPOTT; and 4) maximal isometric/dynamic strength tests in leg curl and leg extension. Creatine kinase (CK) and lactate dehydrogenase (LDH) were determined over the whole training period. Furthermore, the person's perceived physical state (PEPS) and the perceived physical pain (visual analog scale (VAS)) were recorded. **Results** According to PEPS and VAS, both interventions were equally demanding from the subject's point of view. Only C+E caused significant increases in PL<sub>2</sub> (C+E: +12% vs. C: +7%) and OBLA (C+E: +8% vs. C: +6%), however, no significant differences were found between groups. Nevertheless, Cohen's d revealed small effects between C+E and C (d=0.38; d=0.32). Significant differences between both groups were found for dLa dtmax-1 (C+E: +12% vs. C: +2%). Furthermore, Cohen's d revealed small effects between both interventions (d=0.49). Only C caused significant increases in VO<sub>2</sub>peak (C: +7% vs C+E: 2%; d=0.37). Fatmax was significantly different between groups with higher change after C (C+E: -6% vs C: +12%; d=0.6). PPOST, MPOTT, MPOW and PPOW were significantly increased for both groups, however, C+E did not differ between each other. Effects for maximal strength could not be observed. Furthermore, only C+E caused significant increases in levels of CK and LDH. **Discussion** In conclusion, the results suggest that long-term endurance training with superimposed E affects aerobic and anaerobic capacity less on systemic level, but rather on a local level. Due to increases in PL<sub>2</sub> and OBLA, higher increases in dLa dtmax-1, and no increase in VO<sub>2</sub>peak we presume that C+E improves glycolytic flux and lactate turnover by increased anaerobic and oxidative enzyme activities more than cardiovascular factors. Therefore, it can be speculated that C+E might contribute to improve endurance training efficiency in performance and health particularly by increasing lactate thresholds. Contact s.mathes@dshs-koeln.de

### NORDIC WALKING AND TIRE-PULLING – CONCURRENT AEROBIC AND ENDURANCE STRENGTH TRAINING? A RANDOMISED CONTROLLED STUDY

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**Introduction** Nordic Walking (NW) has become a popular way of doing endurance training. One aim of NW is to increase the working load through arm work. This can be better accomplished when pulling an object, such as a tire. Endurance training can be done as low intensity, long duration training (LD), lactate threshold training with moderate duration, or high intensity interval training with short duration (HIIT), (Seiler and Tønnessen, 2009). The aim of this study was to investigate the feasibility of NW and tire pulling in long distance training and HIIT on the development of endurance strength and aerobic power. **Methods** Students volunteered and were randomised by drawing lots into a Control Group (CG), a Long distance training group (LD) and a High intensity interval training group (HIIT). The results from the 34 students that completed at least 75% of the training sessions are reported. After eight weeks of training, CG consisted of 12 persons, LD of 8 persons and HIIT of 14 persons. Their age spanned from 19 to 49 yr, and almost 2/3 of the subjects were females. The participants completed, prior to and after the intervention period, a lactate threshold test plus a maximal oxygen uptake test. Measurements of arm, leg and core strength, blood pressure, spirometry and anthropometric data were also included. The LD group had 60 minutes supervised training 3 x week. The training intensity was between 70 – 85% of HR<sub>max</sub>. Total training time was 24 hours. The HIIT group had the same training frequency. The sessions had 10 minutes warm-up and 10 times maximum intensity intervals of 20 s with 10 s rest. Total training time was 6 hours. The control group continued with their regular training habits. Group means were compared with one-way ANOVA. A p-value ≤0.05 was considered statistical significant. **Results** The following findings were considered significant: HIIT increased VO<sub>2</sub>max with 5%, Lactate Threshold speed with 6% and Time to exhaustion with 8%. Arm strength increased 25% and Leg strength 24%. LD increased their Leg strength with 37% and Core strength with 22%. CG decreased Time to exhaustion with 4%. Systolic and diastolic blood pressure decreased ~8% in LD and HIIT. Body mass, waist circumference and hip circumference did not change significantly for either of the groups. **Discussion and Conclusion** In the present randomised controlled training study NW with tire pulling has been tested out as a functional training method in endurance as well as strength training with low and high intensity. The results show that the HIIT group increased endurance and strength with a modest training time, 6 h. The LD group improved core stability and leg strength, but needed 24 h training. This study indicates that NW with tire pulling may serve as an effective concurrent training with documented effect on both strength and endurance in young, trained individuals. References Seiler, S. and Tønnessen, E. Sports Science 13, 32–53, 2009. Contact asgeir.mamen@nhck.no

### A COMPARISON OF TRAINING LOAD GUIDED VS. CONVENTIONAL ENDURANCE TRAINING IN RECREATIONAL ENDURANCE RUNNERS

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2: Polar Electro Oy, Kempele, Finland **Introduction** Programming endurance (E) training sessions requires instant feedback about the training load and recovery status of an individual athlete (Banister et al. 1980). The Polar Training Load feature aims at continuously monitoring training load based on heart rate recordings throughout each training session and individual physiological variables including age, gender, metabolic thresholds and VO<sub>2</sub>max. This study investigated the effects of E training performed either according to the Polar

Training Load feature or conventionally in recreational E runners. Methods All 24 men ( $34 \pm 7$  yrs,  $77 \pm 8$  kg) performed first 12 wks of similar E training. Thereafter, the subjects were matched by VO<sub>2</sub>max to a training load guided (TL, n=10) or conventional (CT, n=14) group and trained for another 12 wks. In TL, a demanding or easy training session or a rest day was chosen daily based on an estimated recovery status. CT followed a polarized training program with 4-6 sessions per wk of low and high intensity and a pre-defined number of resting days. The training in TL was similar but was performed with modified duration or intensity, if recommended by the recovery status. VO<sub>2</sub>max, time to exhaustion (Tmax) and running velocity at 4 mmol/l blood lactate concentration (OBLA) were assessed by an incremental treadmill test. Results Significant main effects for VO<sub>2</sub>max, Tmax and OBLA were found for time but not interaction. During the first 12 wks of similar training, VO<sub>2</sub>max, Tmax and OBLA increased in TL (5-6%,  $p=0.028-0.004$ ) and CT (4-7%,  $p=0.022-0.009$ ). During wks 13-24, total training time and the number of weekly sessions did not statistically differ between the two groups. The weekly training impulse (TRIMP) was higher in TL than CT ( $375 \pm 47$  vs.  $328 \pm 41$ ,  $p=0.017$ ). VO<sub>2</sub>max, and Tmax significantly increased in CT ( $3 \pm 4\%$ ,  $p=0.034$  and  $3 \pm 3\%$ ,  $p=0.007$ ). During wks 0-24, VO<sub>2</sub>max, Tmax and OBLA increased similarly in both TL (7-9%,  $p=0.013$  to  $<0.001$ ) and CT (6-10%,  $p=0.027-0.001$ ). Discussion This study showed that TL was similarly effective as CT for recreational E runners. Interestingly, while the total training time and the number of weekly training sessions was similar in the two groups, the weekly TRIMP during wks 13-24 was significantly higher in TL compared to CT. Our findings indicate that the Polar Training Load guidance resulted in higher weekly TRIMP leading to no further performance benefits when compared to the present polarized E training. Whether TL is more beneficial than CT in elite E runners with more pronounced needs of higher training intensities and optimized recovery remains to be investigated. References Banister EW, Calvert TW (1980). *Can J Appl Sport Sci*, 5, 170-176. Contact moritz.schumann@jyu.fi

## Oral presentations

### OP-BN05 Kinematics

#### DOES HEAT STRESS MODIFY THE BIOMECHANICAL MANIFESTATION OF FATIGUE DURING REPEATED RUNNING SPRINTS?

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Introduction Fatigue substantially alters force production/application characteristics and impact parameters during run-based repeated-sprint exercise. To date, whether hot ambient conditions exaggerate the biomechanical manifestation of fatigue remains undetermined, as description of repeated-sprint running mechanics has hitherto been limited to temperate environments. Therefore, we investigated alterations in running kinetics and kinematics during repeated sprints performed with or without heat stress. Methods Eleven recreational male athletes (team- and racket-sport background) performed three sets of five 5-s sprints with 25-s recovery and 3 min between sets on an instrumented sprint treadmill (ADAL3D-WR) after a ~30-min warm-up. These were randomly conducted in COOL ( $24.9 \pm 0.6^\circ\text{C}$ ,  $45.3 \pm 7.8\%$  RH) and HOT ( $37.6 \pm 2.3^\circ\text{C}$ ,  $21.4 \pm 3.1\%$  RH) ambient conditions. Mechanical data consisted of continuous (step-by-step) measurement of running kinetics and kinematics for each sprint, which were averaged for each set for further analysis. Results Mean skin ( $37.2 \pm 0.7$  vs.  $32.7 \pm 0.8^\circ\text{C}$ ;  $p < 0.001$ ) and rectal ( $38.9 \pm 0.2$  vs.  $38.8 \pm 0.3^\circ\text{C}$ ;  $p < 0.05$ ) temperatures together with thermal sensation ( $6.6 \pm 0.7$  vs.  $4.7 \pm 0.8$ ;  $p < 0.001$ ) and thermal comfort ( $6.3 \pm 0.9$  vs.  $5.0 \pm 0.6$ ;  $p < 0.001$ ) were higher following repeated sprinting in HOT than in COOL. Distance ran in 5 s and propulsive power decreased from set 1 to set 3 (-7.0% and -14.2%;  $p < 0.05$ ), with lower values (-3.5% and -6.8%;  $p < 0.05$ ) in set 2 in HOT vs. COOL. Disregarding the environmental condition, mean vertical (-0.9% and -2.6%;  $P=0.297$  and  $p < 0.01$ ), horizontal (-5.2% and -9.1%; both  $p < 0.001$ ) and resultant ground reaction forces (-1.2% and -3.0%;  $P=0.161$  and  $p < 0.01$ ) decreased in sets 2 and 3 compared to set 1. Contact and swing times increased from the first to the third set (+9.6% and +4.8%;  $P < 0.001$ ), but averaged values for the three sets were higher in HOT compared to COOL (+3.2% and +2.4%;  $p < 0.001$ ), while flight time and stride length remained constant. From set 1 to set 2, larger reductions in stride frequency occurred in HOT (-4.8%) compared to COOL (-2.7%;  $p < 0.05$ ), stride frequencies being 3.4% and 3.0% slower in set 2 and set 3 in the heat ( $p < 0.001$ ), with no additional alterations between sets 2 and 3. Discussion We confirm that kinetics and kinematics deteriorate substantially during multi-set repeated sprinting. In the heat, higher whole-body temperature and perceptual strain are associated with slightly larger alterations in running kinematics (mostly visible in set 2), but not kinetics. Contact olivier.girard@unil.ch

#### BIOMECHANICAL ANALYSIS OF ELITE SPRINT KAYAKER USING FIXED AND SWIVEL SEAT: A PILOT STUDY

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BIOMECHANICAL ANALYSIS OF ELITE SPRINT KAYAKER USING FIXED AND SWIVEL SEAT: A PILOT STUDY Introduction Sprint kayaking race became more competitive since the introduction of 200 metre event in the 2012 Olympic Games. A more intense application of an effective and powerful paddling execution is needed. The present study aimed to investigate the effect on kinematics and kinetics variables between the fixed and swivel seat in 200 metre and 1000 metre simulated race. Methods The test was conducted using a modified kayak simulator system in laboratory setting. The subject was an elite flat water sprint kayaker, started the session with a self-paced warm up. The type of seat was randomly assigned and the subject was required to perform an all-out kayak simulation test (i.e. 40 seconds for 200 m event and 3 minutes 30 seconds for 1000 m event) on two separate testing days. Ten left and right strokes with the highest paddle peak force value in both events were selected for statistical analysis. Results Only the paddle force and foot force showed significant difference ( $p < 0.01$ ) during the 200 m test using the swivel seat. All the variables, which consisted of paddle force, foot force, stroke time and stroke rate in 1000 m were statistically different ( $p < 0.01$ ) across seat conditions. Correlation value of more than -0.9;  $p < 0.01$  was obtained in the stroke time and stroke rate in both events and seat conditions. Strong correlations of value more than 0.9;  $p < 0.01$  were also found between foot force with the opposite side of paddle force in all conditions. Discussion Varied outcomes were found in both simulated races with more obvious changes observed in 1000 m test using the swivel seat. Such differences observed here might be helpful as a guideline for the coaches in the preparation of specific training in the relevant race distance. High correlations of the foot force causing the contralateral force generation on the opposite side of the paddle force played an important role as a chain of relation in power transfer with the use of lower limbs pedalling motion. Such motion is effective by utilising the larger muscle groups and not depending solely on arm strength alone, especially beneficial for long distance race. As suggested by McDonnell, Hume and Nolte

(2013), a decrease in stroke time will improve the stroke rate which had a high relation with kayak velocity. The results presented is limited to this single subject study and based only on the ten selected strokes which will require a bigger pool of subjects in the future for a more in depth findings. References McDonnell, L. K., Hume, P. A., & Nolte, V. (2013). A deterministic model based on evidence for the associations between kinematic variables and sprint kayak performance. *Sports Biomechanics*, 12(3), 205-220. Contact Corresponding author: ylok7701@uni.sydney.edu.au

### **VALIDATION OF MEASURING ROWERS' CENTRE OF MASS ACCELERATION IN ROWING DIRECTION WITH INERTIAL SENSORS**

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**Introduction** Rowing performance depends on maximization of mechanical power delivered by the rower(s) and minimization of power losses during a stroke cycle (Hofmijster et al., 2008). In many cases, a rower's mechanical power has been calculated by multiplying the moment of the oar with oar angular velocity (e.g. Baudouin&Hawkins, 2004). However, due to the boat speed being unsteady (Hofmijster et al., 2008; Baudouin&Hawkins, 2004), a secondary power term -related to the rower's centre of mass (CoM) acceleration- needs to be incorporated. In this study we evaluated whether horizontal CoM acceleration of the rower during ergometer rowing could be estimated by using a magneto-inertial suit. **Methods** Ten participants (5 male and 5 female) rowed 7 trials on an ergometer placed on two force plates. For each trial, stroke rate per minute (15, 25, 35, ascending stroke rate) or technique (early leg extension, early back extension, stroke to recovery ratio 2:1) was manipulated. The rower's CoM acceleration in rowing direction was calculated (100 Hz) from the weighted average (Hof, 1989) of the accelerations of 17 inertial sensors of an Xsens MVN motion capture suit (Roetenberg et al, 2013), each strapped to a separate body segment. Validating the accuracy of this calculation, this CoM acceleration was compared to the rower's CoM acceleration as determined by the force plates, namely the recorded inertial force divided by the mass of the rower. **Results** For every trial, 10 strokes in the middle of the trial were selected. Statistics showed that the rower's CoM acceleration in rowing direction determined with inertial sensors ( $0.52 \text{ m/s}^2 \leq M \leq 5.53 \text{ m/s}^2$ ) was strongly correlated with the rower's CoM determined with the force plates ( $0.49 \text{ m/s}^2 \leq M \leq 5.87 \text{ m/s}^2$ ) for every participant in every trial ( $0.98 \leq r \leq 1.00$ ,  $0.09 \text{ m/s}^2 \leq \text{SEE} \leq 0.95 \text{ m/s}^2$ ). **Discussion** This study shows that a rower's CoM acceleration in rowing direction can be calculated accurately by means of an inertial magnetic suit. This suggests that this technology could be used to measure the secondary mechanical power term related to the rower's CoM acceleration. On-water studies will be conducted to test the magnitude of this power term. **References** Baudouin, A., & Hawkins, D. (2004). *J Biomech*, 37 (7), 969-976. Hof, A.L. (1989). *J. Biomech*, 1209-1211. Hofmijster, M.J., Van Soest, A.J., & De Koning, J.J. (2008). *Med Sci Sports Exerc*, 40 (6), 1101-1110. Roetenberg, D., Luinge, H., & Slycke, P. (2013). Xsens Technologies. Contact l.l.lintmeijer@vu.nl

### **QUANTITATIVE COMPARISON OF ROWING BIOMECHANICS CAPTURED ON WATER AND ON A DYNAMIC ERGOMETER**

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**Introduction** Ergometers are widely used for fitness training in rowing (land). However, they are not considered appropriate for skill acquisition training. When comparing rower biomechanics during water and land Elliott et al. (2002) suggest similar technique is achieved while Fleming et al. (2014) show significantly different upper leg muscle recruitment patterns. We present a novel parameterisation of rowing biomechanics applicable in both environments. **Method** Sigrist et al. (2013) demonstrate the application of augmented feedback during land rowing. To justify such a coaching intervention it is necessary to quantitatively compare the biomechanics of the two modalities with specific reference to the component of the rowing skill being trained. In this study sub-elite rowers performed step rating tests in a single scull and on an instrumented ergometer. Boats carried an accelerometer; the ergometer recorded rower forces applied at the foot stretcher and handle. Rowers' biomechanical parameters for the drive, recovery and front reversal phases were calculated and statistically compared for every stroke. **Discussion** The efficacy of applying augmented feedback during water rowing is not yet fully understood. Concurrent feedback is promoted at low stroke rates to influence handle force profiles and hull dynamics (Altenburg et al., 2012). This is offset by: difficulty in isolating skills of individuals during crew rowing, increased complexity of the water environment, reliably relaying information to the rower and interrupting normal training. We hypothesise that indoor rowing is a more appropriate environment to deliver concurrent feedback providing the differences between the two environments are understood. Extending the work by Baca et al. (2006) that compared rower forces applied on land and water, we parameterise the resultant force of the rower and undertake novel quantitative comparison. The efficacy of performing concurrent feedback training on a dynamic ergometer is determined. **References** Altenburg, D. et al. (2012). *Manual for rowing training: Technique, high performance and planning* Limpert Verlag GmbH, Wiebelsheim. Baca, A. et al. (2006). *Feedback systems in rowing*. In E. F. Moritz & S. Haake (Eds), *Proc. of the International Sports Engineering Association*, Vol. 1, pp. 407-412. Munich, Germany. Elliott, B. et al. (2002). *The RowPerfect ergometer: a training aid for on-water single scull rowing*. *Sports Biomechanics*, 1(2), 1-15. Fleming, N. et al. (2014). *A comparison of electromyography and stroke kinematics during ergometer and on-water rowing*. *Journal of Sports Sciences*, 32(12), 1-12. Sigrist, R. et al. (2013). *Terminal feedback outperforms concurrent visual, auditory and haptic feedback in learning a complex rowing-type task*. *Journal of Motor Behavior*, 45(6), 455-472.

### **DETECTING FATIGUE IN RESISTANCE TRAINING USING ACCELEROMETRY AND PCA**

Brown, N., Bichler, S., Fiedler, M., Alt, W.

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**Introduction** Detection of objective fatigue in resistance training is difficult, due to missing criterion measures and complex fatigue characteristics. Thus a variety of methods is used to determine fatigue, including electromyography (Rogers & MacIsaac, 2013), kinematics (Sánchez-Medina & González-Badillo, 2011) or perception (Day et al., 2004). However, recent research indicates a beneficial fatigue detection if multifactorial parameters are used. Principal component analysis (PCA) has previously been used to detect fatigue in sports (Witte et al., 2011). The aim of this study was to use PCA on a multifactorial dataset based on kinematic measurements to determine fatigue. **Methods** Twenty subjects (60% male, resistance training experience) were tested for 12-repetition maximum (RM). In a second session, 3 sets of 3 exercises were executed with 50 (12 repetitions), 75 (12 repetitions) and 100% of individual 12 RM (RM). Data were collected with a 3D-accelerometer and analyzed by a newly developed algorithm (Brown, Bichler, & Alt, 2014) to get time features and range of motion for each repetition. A PCA with six variables was carried out on the results. The loadings of the variables on the first component were then used to calculate a fatigue factor. ROC-Curves were used to define a threshold between fatigued and non fatigued

exercises. One-way ANOVA with Bonferroni post-hoc analysis was calculated to test for differences between the intensity levels. Results The first component explained 57% of total variance. All six input variables had high loadings on the first component. The ROC-Curves revealed a fatigue score value of 0.56 to distinguish between fatiguing and non-fatiguing exercises. 95% of the non-fatiguing exercises were below threshold. The ANOVA showed a significant difference between intensities ( $p < 0.001$ ). Post-hoc analysis revealed a difference between 100% and the lower intensities ( $p < 0.05$ ) and no difference between 50 and 75%-12RM. Discussion Based on the results of this study, it is possible to distinguish between fatigued and non-fatigued sets of resistance training based on acceleration data with a single parameter calculated by a linear combination of set-specific features gained from PCA. References Brown, N., Bichler, S., & Alt, W. (2014). Journal of Sports Engineering and Technology, submitted. Day, M., McGuigan, M., Brice, G., & Foster, C. (2004). J Str Cond Res, 18(2), 353–358. Rogers, D. R., & MacIsaac, D. T. (2013). J Electromyogr Kinesiol, 23(5), 1004–11. Sánchez-Medina, L., & González-Badillo, J. J. (2011). MSSE, 43(9), 1725–34. Witte, K., Heller, M., Baca, A., & Kornfeind, P. (2011). In Proceedings of the 8th International Symposium on Computer Science in Sport (pp. 41–44). World Academic Press. niklas.brown@inspo.uni-stuttgart.de

## Oral presentations

### OP-BN08 Balance & Stability, Coordination

#### PREDICTING THE ROLE OF KNEE JOINT MUSCLES IN JOINT STABILIZATION FROM EXTERNAL MOMENTS

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Due to their anatomical orientation, major muscles crossing the knee are categorized as flexors or extensors, and can efficiently oppose loads in the sagittal plane. Yet, knee loads are not limited to a single axis. Cocontraction of the flexors and extensors are suggested to support frontal and transverse plane loads since their moment arms too possess varus-valgus and rotational moment arm components [1]. The purpose of this study was to determine the influence of knee joint moments on the activation of knee joint muscles. A force matching protocol [2] evaluated muscle activation patterns of 23 healthy young adults. Subjects stood with leg of interest fixed to a force platform and modulated ground reaction forces (GRFs). Surface EMG, kinetics and kinematics were recorded while subjects generated 30, 45 and 60% of their maximal GRF in 12 different directions to elicit various combinations of flexion-extension, ab-adduction, and rotational knee moments. While controlling for GRF direction and effort level, multiple stepwise linear regressions was used to assess the ability of knee moments to the predict levels of muscle activation. Significant contributions to the model were determined when input variables yielded  $R^2$  Change  $> 0.05$ . The model was a weak predictor of the mono-articular vastii muscles ( $R^2 < 0.21$ ), meaning their activation is not load dependent. We have previously described roles of muscles as it relates to joint stability [2] and based on the current results, we classify the mono-articular vastii as general joint stabilizers. In contrast, strong model correlations, indicating load dependency, were observed in the other bi-articular muscles ( $R^2 = 0.51-0.81$ ). Differences in the roles mono- and bi-articular muscles play in lower limb force control has been described by [3]: mono-articular muscles provide a general gross force while the bi-articular muscles “fine tune” the distribution of net joint moments across adjacent joints. Beta indicates the number of stDev that muscle activation would change with 1 stDev change in a moment. Rectus femoris (RF) was best predicted by its extensor function ( $\beta = 0.52$ ). The greatest predictor of medial (MH) and lateral hamstrings (LH) were internal rotation ( $\beta = 0.36$ ) and adduction moments ( $\beta = 0.39$ ), respectively. Flexion was the second significant predictor of MH and LH activation ( $\beta = 0.33 \& 0.17$ ). We classify RF as a movement facilitator, and hamstrings as specific joint stabilizers, indicating the hamstrings have a more complex role in knee joint stability, beyond that of generating flexion moments. Further investigation into muscular support for frontal and transverse knee loads is warranted. References: [1] Lloyd, 2001. J Biomech 34, 1257-67 [2] Flaxman, 2012. J Biomech 45, 2570-6 [3] van Ingen Schenau, 1992. Neurosci 46, 197-207

#### SQUAT VARIATION FOR PREFERENTIAL UNILATERAL QUADRICEPS LOADING

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Introduction Persons with anterior cruciate ligament (ACL) injury have unilateral quadriceps weakness. To date, no rehabilitative approach, including single- and multi-joint unilateral and bilateral exercises, satisfactorily restores quadriceps strength in the involved limb [3]. The purpose of this research was to examine if squat exercise could be modified to preferentially load the quadriceps in one limb. We hypothesized that squats with one limb on an elevated surface would increase knee extensor net joint moment (NJM) and quadriceps EMG activity in the contralateral limb. Methods Five men and 5 women performed 2 sets of 5 repetitions each of plate squats [2] under normal, left limb elevated and right limb elevated conditions. For limb elevated conditions the foot was placed on a 5cm platform. Motion analysis was performed with 7 optoelectronic cameras and two force platforms. Vastus lateralis (VL), vastus medialis (VM) and rectus femoris (RF) activity were recorded with bipolar electrodes. Inverse dynamics was used to calculate knee NJM. EMG data were filtered and processed using a 100ms window root mean square. For all data, the average value was calculated for 15 degree knee flexion intervals during eccentric and concentric phases [1]. Results With the right limb elevated, left knee extensor NJM increased resulting in greater contra- versus ipsilateral knee extensor NJM. VL and VM EMG increased in the contra- and decreased in the ipsilateral limbs. With the left limb elevated, right knee extensor NJM was greater than left when knee flexion was less than 90 degrees. Contralateral VL, VM and RF EMG increased while ipsilateral VL and VM EMG decreased at some squat depths. Regardless of condition, knee extensor NJM and quadriceps EMG were largest at high knee flexion angles. Discussion Elevating a single limb appears to increase quadriceps loading in the contralateral limb while decreasing quadriceps loading in the ipsilateral limb. Therefore, this squat variation may be useful to target unilateral quadriceps weakness, such as in ACL injured persons, by elevating the non-involved limb. However, these findings were most robust with the right limb elevated, whereas left limb elevated trials showed effects only at shallow knee flexion angles. Further examination of this squat variation with ACL injured persons is warranted. Regardless of the variation, full squat exercise may be required to increase quadriceps strength – including in ACL injured – as quadriceps loading is highest when knee flexion is greater than 105 degrees. References 1. Bryanton et al. (2012). J Strength Cond Res, 26, 2820-2828. 2. Chiu, Burkhardt (2011). Strength Cond J, 33(2), 46-54. 3. Salem et al. (2003). Arch Phys Med Rehab, 84, 1211-1216. Contact ljean@ualberta.ca

## UNSTABLE FOOTWEAR DECREASES COMPLEXITY OF POSTURAL CONTROL

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**Introduction** Although the effects of unstable shoes (US) on pain relief and on promoting strength, stability or proprioception abilities are well acknowledged (Nigg et al., 2012), the basic motor mechanisms involved have not yet been fully understood. Therefore, the aim of the current study was to upgrade the framework of US by investigating the complexity of centre of pressure (COP) patterns through tools assessing the structure of corresponding fluctuations. **Methods** Twenty-nine healthy men conducted three bipedal standing trials using US (M-Walk, MBT) or flat footwear (Vellum 2, Puma) in a counter-balanced within-subject design. Simultaneously, kinetic signals were captured for 30 seconds by a six-component AMTI force platform, sampling data at 100 Hz. After reconstructing medio-lateral (COPx) and anterior-posterior (COPy) COP trajectories each coordinate was low-pass filtered and normalised to unit variance. For quantifying the complexity of COP profiles, fractal- and entropy-based indices derived from detrended fluctuation analysis (DFA) and multi-scale entropy (MSE) calculations (Duarte & Stenard, 2008) were computed and statistically processed employing a two-way repeated measures ANOVA (shoe x direction) – with Alpha fixed at 0.05. **Results** Compared to the control condition DFA and MSE outcomes revealed higher scaling exponents and a decrease in sample entropy estimates of the overall COP sway when wearing US (shoe: all  $P < 0.001$ ; all  $f > 0.40$ ); however, these changes were consistently greater in COPx than in COPy time series (shoe-by-direction: all  $P < 0.05$ ; all  $f > 0.40$ ). **Discussion** US caused system responses which were more closely related to the dynamics of a random walk, meaning that COP deviations occurred along fewer time-scales and demonstrated a more predictable sequence. Consequently, participants performed numerous, active postural adjustments – via recruiting hip muscles as well – for combating the requirements of US. This type of compensatory strategy generally suggests a fixation of independent degrees of freedom in control space since an intensified coupling of functional units governing a steady-state position can be expected (Duarte & Stenard, 2008; Hong et al., 2008). If true, the resultant loss of physiological complexity following an US intervention would again point towards a certain potential of the underlying construction concept to serve as an extrinsic constraint applicable in every-day settings (Stöggel et al., 2010). **References** Duarte M, Stenard D (2008). *Exp Brain Res*, 191(3), 265-276. Hong SL, James EG, Newell KM (2008). *Dev Psychobiol*, 50(5), 502-510. Nigg B, Federolf PA, von Tscharnar V, Nigg S (2012). *Footwear Sci*, 4(2), 73-82. Stöggel T, Haudum A, Birklbauer J, Murrer M, Müller E (2010). *Clin Biomech*, 25(8), 816-822. Contact michael.buchecker@sbg.ac.at

## STATIC POSTURAL CONTROL DOES NOT STRONGLY PREDICT DYNAMIC GAIT STABILITY RECOVERY FOLLOWING A TRIP IN ADULTS WITH AND WITHOUT VESTIBULAR DYSFUNCTION

McCrum, C.1,2, Eysel-Gosepath, K.3, Epro, G.2, Meijer, K.1, Savelberg, H.1, Brüggemann, G.P.2, Karamanidis, K.2

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**Introduction** Unilateral peripheral vestibular disorder (UPVD) disrupts vestibular sensory feedback information, negatively affecting upper and lower body motor performance (Raptis et al., 2007; McCrum et al., 2014), but postural control during quiet stance in UPVD patients has not been directly compared with dynamic stability control after an unexpected perturbation during locomotion. Therefore, we analysed centre of pressure (COP) characteristics during static posturography in UPVD patients and healthy controls and compared this with performance of a trip recovery task. **Methods** 17 UPVD patients and 17 healthy matched controls were unexpectedly tripped during the swing phase of the right leg while walking on a treadmill. The margin of stability (MoS) was calculated at touchdown (TD) of the perturbed step and the first six recovery steps to analyse recovery and dynamic stability control (Süptitz et al., 2013). Posturography was used to assess postural stability during 30 seconds of quiet standing with eyes open and closed using a force plate. Pearson correlations between the trip recovery task and posturography outcome measurements were conducted. **Results** The unexpected trip reduced the MoS of the perturbed leg ( $p < 0.05$ ) with no significant differences in MoS between the groups. Controls returned to MoS baseline level in five steps and patients did not return within the six analysed steps. UPVD patients showed a significantly greater total COP sway path excursion (closed eyes only), anterior-posterior range of COP distance and a more posterior COP position in relation to the posterior boundary of the base of support (COPpmin). There were no significant correlations between COP sway path excursion and MoS values. Significant correlations were found only between the COPpmin and the MoS at TD of the second to fourth steps post-perturbation ( $0.4 < r < 0.57$ ;  $p < 0.05$ ). **Conclusion** We concluded that UPVD patients have a diminished ability to control and recovery dynamic gait stability after an unexpected trip and lower static postural stability control compared to healthy matched controls. As no consistently significant relationship between task performances was found, it appears that trip recovery and static postural control rely on different control mechanisms. Therefore, static posturography may be of limited use in predicting dynamic stability during perturbed walking. **References** Raptis et al. *J Neurophysiol*, 2007; 97: 4069-78 McCrum et al. *Physiol Rep*, 2014; 2(12): e12222 Süptitz et al. *Hum Mov Sci*, 2013; 32: 1404-14 Contact chris.mccrum@maastrichtuniversity.nl

## THE EFFECT OF AN 8-WEEK CORE-STABILITY PROGRAM ON COORDINATION DYNAMICS AND KICKING SPEED IN FEMALE SOCCER PLAYERS.

Serrien, B., Steiner, V., Clijse, R., Baeyens, J.P.

*Vrije Universiteit Brussel*

**Introduction.** In this study we wanted to analyze the effect of core-stability (CS) training on ball speed (BS) and coordination dynamics (CD) in a penalty kick from a single-subject point-of-view. The constraints model (organismic-task-environment) and the self-organization principle offer a useful framework to study CD. In this study, we focused on the effects of altered neuromuscular constraints after an 8-week CS intervention. **Methods.** Twenty-five female soccer players (median age 16) from the Austrian 2nd league participated in this study. After subjects were age- and anthropometrically matched, they were randomized between an intervention (I4) and control group (CON, 11) who followed their normal soccer training. The intervention group received a CS exercise program for 8 weeks, 2 times a week for 30 minutes beside their normal soccer training. CD in 12 penalty kicks was analyzed with self-organizing maps (SOM) for every subject separately with the method described by Lamb et al. with as input vector 20 kinematic time series (joint angles and – velocities of pelvis, trunk and kicking leg) during the penalty kick. We hypothesized that the CON subjects would have their local minima of the coordination potential on the same nodes of the SOM and that the local minima of the intervention subjects would be shifted. Analysis of BS was done for every subject with a paired t-test. **Results.** In the intervention group, 1 subject showed a significantly increased BS and 3 subjects showed a sig. decreased BS. In the CON, 3 subjects showed a sig. increase and 1 subject a sig. decrease. The results of the CD analysis

with the SOM's showed that most players exhibited a mono-stable coordination potential on both sessions. The hypothesis could not be confirmed: from both groups, subjects had altered coordination patterns. These shifts in coordination are thus probably only day-to-day variability and no systematic alteration. Discussion. The results indicate that the intervention program focusing on CS was not effective in improving BS or altering the CD because of altered organismic constraints. Various reasons contribute to this result, including low adherence to the training regimen of some subjects and a very heterogeneous group on several other not controlled factors such as CS experience and soccer experience. Organismic constraints are much more difficult to alter on a systematic basis. Further research with a simpler motion and more experimental control will be necessary to study the effect of organismic constraints on CD. References Lamb et al. 2011 Hum Mov Sci 30 1129-43 Contact bserrien@vub.ac.be

### **THE EFFECT OF FORCE-CONTROLLED BITING ON MOTOR CONTROL – EXPERIMENTAL STUDIES UNDER LABORATORY AND FIELD CONDITIONS**

Ringhof, S.1, Hellmann, D.2, Schindler, H.J.2, Potthast, W.3, Meier, F.1, Etz, E.2, Stein, T.1

1: Karlsruhe Institute of Technology; 2: University of Heidelberg; 3: German Sport University Cologne

**Introduction** Human motor control is based on complex sensorimotor processes, including diverse sensory systems. Trigeminal connections to several structures involved in motor control (Buisseret-Delmas et al., 1999) further imply that human movements could be influenced by the input of the craniomandibular system (CMS). Recent studies showed that changes of the CMS, like jaw motor tasks and oral devices, did not only enhance postural stability (Hellmann et al., 2011), but also improve performance in high level shooters (Gangloff et al., 2000). The aim of our study was, therefore, to investigate whether oral motor tasks likewise influence (A) postural control in more challenging situations, and (B) performance in coordinative demanding full-body motor tasks, as golf shots. **Methods** In experiment A twelve healthy subjects performed force-controlled (FB) and non-biting while balancing in unipedal and bipedal narrow stance. Postural stability and joint kinematics were evaluated by means of center of pressure (COP) displacements detected by use of a force plate, and biomechanical motion analysis, respectively. In addition, electromyographic activity of six postural muscles was recorded. Field study B investigated the effect of FB on shot precision (60 m, 160 m) and shot length (Drive) in 14 professional golfers; with golf performance being quantified by means of a radar based system. The bite forces in both studies were visualized as real-time feedback. **Results** In study A, COP displacements were significantly reduced during FB, accompanied by smaller ranges of motion and lower mean angular velocities in hip, knee and ankle joints in both frontal and sagittal planes. Furthermore, muscular co-contraction variability in five of six muscle pairs was significantly reduced during FB. In study B, however, oral motor tasks did not systematically affect any performance variable under investigation. **Discussion** The results of study A showed that biting at a submaximum level also improved postural control in more demanding situations, and thereby reinforced the impact of the CMS on human motor control. Joint kinematics and co-contraction variability, moreover, revealed that neuromuscular control strategies might be more precise under FB. Notwithstanding this, study B indicates that the stabilizing (study A) and performance enhancing effects (Gangloff et al., 2000) apparently are not transferable to coordinative demanding full-body movements. The empirical and clinical relevance of the functional impact of the CMS, thus, needs to be investigated in further studies. **References** Buisseret-Delmas C, Compoin C, Delfini C, Buisseret P (1999). J Comp Neurol, 409, 153-168. Gangloff P, Louis JP, Perrin PP (2000). Neurosci Lett, 293, 203-6. Hellmann D, Giannakopoulos NN, Blaser R, Eberhard L, Schindler HJ (2011). J Oral Rehabil, 38, 1-8. Contact steffen.ringhof@kit.edu

## **Oral presentations**

### **OP-SH17 Physical Education & Pedagogics III**

#### **GIVING THE ATHLETE A VOICE: PRELIMINARY FINDINGS OF THE MY SPORTING JOURNEY QUESTIONNAIRE.**

Juanita, W., Warmenhoven, J., Medlicott, R., Gulbin, J.P.

*Australian Institute of Sport*

Within the Australian Sporting system, the operational framework of FTEM (Foundation, Talent, Elite & Mastery) (Bergeron et al 2015, Gulbin et al 2013,) in complement with the conceptual model of 3D-AD (3D-Athlete Development, Gulbin & Weissensteiner 2013) provides a practical and best practice approach for guiding sporting stakeholders across the span of the development pathway. Such an approach is assisting in aligning athlete and coaching educational initiatives, promoting innovative and ecological development practices and fostering the progressive and reactive, interdisciplinary case management of athletes. Central to informing this strategy, is engaging the 'athlete's voice' –regarding the relative impact of intrinsic and extrinsic factors (environmental, system, chance) on their development, progression, transition and performance (Weissensteiner, 2015). The My Sporting Journey Questionnaire, sought to give contemporary Australian Olympic, Paralympic and Professional athletes a voice regarding their developmental experiences both positive and negative. **Method:**The My Sporting Journey questionnaire captures and chronicles holistically, the developmental history of each athlete from their early foundational experiences to their highest level of competition and development according to the FTEM framework. The questionnaire was administered online to over 800 athletes from numerous Olympic, Paralympic and Professional sports and included over 280 elite and mastery level athletes. **Results:**Preliminary findings revealed inter alia differences between the male and female developmental experience; unique characteristics of Mastery level athletes; common foundational catalysts preceding expertise; the high influence of peers, mentors and role models on development; critical transition points in the pathway and aligned barriers and facilitators; and the impact and breadth of high performance stressors. **Discussion:** Collectively, the findings provide strong evidence to guide and refine current practice and the support of athletes across the entire development pathway, at a gender and sport-specific level. Utilising an evidence-informed approach informed by the athlete voice ensures that ensuing strategies supporting the athlete are grounded, relevant and effective. Bergeron MF, Mounjoy M, Armstrong N, et al. International Olympic Committee Consensus Statement on Youth Athletic Development. (Submitted for publication). Br J Sports Med. 2015. Gulbin JP, Croser MJ, Morley EJ, et al. An integrated framework for the optimisation of sport and athlete development: a practitioner approach. J Sports Sci 2013;31:1319-31. Gulbin JP, Weissensteiner J. Functional sport expertise systems. In: Farrow D., Baker J., MacMahon C., editors. Developing sport expertise – Researchers and coaches put theory into practice. 2nd ed. London: Routledge; 2013. pp. 45-67. Weissensteiner J. The Importance of Listening: Engaging and incorporating the athlete's voice in theory and practice. (Accepted for publication). Br J Sports Med. 2015.

**RELATIVE AGE EFFECT AND PHYSICAL GROWTH ON PHYSICAL EDUCATION ATTAINMENT**

Dalen, T., Roaas, T.V., Pedersen, A.V., Ingvaldsen, R.P., Steen, I., Aune, T.K.

*Nord-Troendelag University College*

Introduction: Physical education (PE) is perhaps the school subject that is most susceptible to the relative age effect (RAE). Though being less competitive and selective than sports, students' attainments rest on their physical performance rather than on academic or cognitive variables as in most other subjects. Like in sports (see for example Musch & Grondin, 2001), physical maturity might give students in physical education an advantage, and this could be mistaken for superior ability. The aim of the present study was to investigate the extent to which the physical growth and RAE reflects the attainment in Norwegian PE. Method: To investigate the influence of date of birth and physical growth measured as body height on physical education attainment we used a questionnaire for pupils in the three last year of secondary school (13 - 16 year). In total 2978 pupils participated in the study representing a large comprehensive area of schools situated in the middle of Norway. Results: In total the correlations between height and mark in PE were  $r = 0.14$ ,  $r = 0.32$  and  $r = 0.29$  for boys in 8th, 9th and 10th grade, ( $p < 0.001$ ) and  $r = 0.11$ ,  $r = 0.33$  and  $r = 0.21$ , for girls in 8th, 9th and 10th grade ( $p < 0.001$ ). The most obvious effect of differences in height was observed when the groups were split into students with high and low attainment. Both boys and girls with high attainment were in average 10 cm higher than students with low attainment. The distribution of the number of top marks per quarter show that it is advantageous to be born early in the year. 114 out of 179 top marks were given to pupils born the first half year. Discussion: Norwegian physical education curriculum emphasizes participation over performance (Norwegian Ministry of Education and Research, 2012), and children's physical capacity and maturation should not directly contribute to their end year attainments, and should neither be monitored according to the curriculum. However, as attitudes and motivation are not so easily measured, there might be used more traditional ratings of sport performance, including physical fitness testing (Cale & Harris, 2009). Such assessments have been proven to be biased and affected by children's relative age and physical maturity. References: Cale, L., & Harris, J. (2009). Fitness testing in physical education - a misdirected effort in promoting healthy lifestyles and physical activity? *Physical Education & Sport Pedagogy*, 14(1), 89-108. Musch, J., & Grondin, S. (2001). Unequal competition as an impediment to personal development: a review of the relative age effect in sport. *Developmental Review*, 21(2), 147-167.

**THE EFFECTIVENESS OF INTER-PROFESSIONAL SIMULATED-PATIENT BASED SIMULATION IN DEVELOPING EXERCISE PHYSIOLOGY STUDENT INDUSTRY READINESS**

Reeves, N., Waite, M., Bialocerkowski, A., Tuttle, N.

*Griffith University*

Introduction Clinical educators and students alike indicate that additional exposure to a wide variety of 'practice' clinical experiences better equips them to effectively manage patients and initiate inter-professional care models when undertaking clinical practicum. This study reports on the impact this style of simulation had on Exercise Physiology student's industry readiness with respect to inter-professional care. Methods This investigation includes the responses to pre- and post- simulation questionnaires from Exercise Physiology students ( $n=14$ ) completing a Graduate Diploma in Exercise Science at Griffith University, Australia. Students completed three inter-professional simulation modules (two with Nutrition & Dietetics students, one with Pharmacy student) covering topics including inter-professional management of a Type 2 Diabetic Patient, Cardiorespiratory Patient, and Cancer-End of Life Care Patient. The simulation modules were facilitated by experienced and accredited practitioners from the respective professions and included pre-reading, briefing, simulation using simulated patients, and debriefing components. Exercise Physiology students were paired with a student from the other profession and the simulation modules were delivered on campus or remotely, via telehealth, to those students embedded in practicum rotations across the state. The pre- and post-simulation questionnaires were designed to elicit quantitative and qualitative information on the reaction, learning and behaviour levels of the Kirkpatrick model. Quantitative data were analysed descriptively and using the Wilcoxon Signed-Ranks Test to investigate changes in students' confidence following the simulations. Themes were derived from open-ended responses. Results Post simulation Intrinsic Motivation Inventory scores indicated high levels of interest, competence, and confidence, and moderate levels of tension (means ranged 5.4 - 6.6, and 2.5 - 4.1 respectively on a 7-point scale). Scores indicated very high levels of perceived impact on skills in communication, assessment, management and the ability to collaborate with other health professionals (means ranged 6.0 - 6.82). Wilcoxon Signed Ranks Test scores indicated significant increases in confidence in communication, patient assessment, management and inter-professional collaboration ( $p < 0.05$ ). Qualitative information supported the quantitative data with students appreciating the opportunity to receive feedback from the simulated patients and facilitators. They identified being able to observe how the other professions' approached the management of the patient and the inter-professional collaboration in developing a treatment plan of significant benefit. Discussion The positive response to the simulation modules and impact on students' learning demonstrates the influence of inter-professional simulated learning on developing Exercise Physiology student industry readiness.

**LYING IN BETWEEN. ABOUT THE CONTINGENCY OF CROSSING.**

Roscher, M.

*Johannes Gutenberg University Mainz*

Existing research currently focuses on practical abilities as the means to enhance performance. Techniques are polished, tactics are improved, and in some cases, mental training is incorporated. What is missing is the understanding of how inner principles such as aesthetics affect sports performance. The oral presentation explores the interplay between aesthetics, sensual awareness, practical abilities, and sports performance. Drawing from ongoing discussions in aesthetic philosophy around the question of sensory perception as an activity, sport philosophers and educators should ask themselves whether sensory perception is based solely on an ability to create sensual understanding, as Baumgarten would put the subject of aesthetics. Herder has proposed the existence of an inner principle beyond the influence of a certain subject. These views set the foundation for explorations of an inner force within aesthetics. If we do read the formation of aesthetics as being a progression resulting from an inner principle without conscious reference to itself, then this inner principle cannot be normative and as a result cannot be a practical ability. The practical ability of an athlete originates from physical exercises. However, this exercising interrupts the aesthetic play. The functioning of the aesthetic is indifferent to the exercise of the practical ability, on the contrary it is necessary for effective exercising: Aesthetic play frees physical activity from standards, laws and purposes. In doing so, it expresses the difference between aesthetic force and practical ability, and furthermore it grasps the human as difference. Within sports we experience a specific mediality of aesthetic practice: the human body itself. The sportsman's activities arise from both, conscious ability as well as ecstatically freed force. And he is not simply using one or the other, but he is the crossing from one to the



other. Practical ability and inner force flow into each other. Thus, enhancing the performance requires more than increasing the practical abilities. It requires the ability to exceed it. Assuming a contingency of crossing exists forces us to examine the physical expertise anew.

### **WHO PARTICIPATE AND WHY?: YOUTH PARTICIPATION IN SWEDISH CLUB SPORTS**

Theidin Jakobsson, B.

*The Swedish School of Sports and Health Sciences*

The main aim of this study is to increase knowledge of what characterizes club sport participation during childhood and youth, and what distinguishes young participators who continue club sport in their late teens and to understand why they continue. An important premise for this study is that sport is one of the most widespread leisure activities among youth. Many young people in Sweden stop participating in club sport during their teens, but some continue. Rather than concentrating on those who drop out of club sports the focus of this study is on the ones who continue with club sports during teenager years. Aaron Antonovsky's salutogenic theory and sense of coherence model (SOC) has inspired the analysis of what it is that seems to be comprehensible, manageable and meaningful when participating in club sport. Furthermore, Pierre Bourdieu's key concept habitus and capital have been used as research tools when analyzing the relationship between sports participation and social position among teenagers. The study is longitudinal where the same 585 pupils born 1991 have answered a questionnaire at 10, 13, 16 and 19 years of age. The results show that club sports are successful in getting large numbers of children to attend and participate, but there seem to be many who just participate for a short time and only about one third stay on in their late teens. Very few start after the age of 13. Teenagers who are active participants appear to have started early, have taken part in different sports and do not mind taking part in competitions. Furthermore, they seem to possess specific dispositions (and certain assets) in terms of a habitus with a taste for sport and a specific cultural capital in terms of academic success. Moreover, it looks as if doing club sport is a social space where the teenagers can experience meaningfulness based on learning, developing physical ability, experiencing a feeling of belonging, and being challenged but few had elite ambitions. The conclusion is that sports clubs should try to organize activities emphasizing development with numerous opportunities and challenges for motor and social learning with less focus on competitions as the only focal point. By asking questions about and taking into account what teens need to understand, cope with, and what they perceive as meaningful in sports, it is possible that more young people want to participate longer. Antonovsky, A. (1979). Health, stress, and coping. San Francisco: Jossey-Bass. Antonovsky, A. (1987). Unraveling the mystery of health: how people manage stress and stay well. San Francisco: Jossey-Bass. Bourdieu, P. (1978). Sport and social class. *Social Science Information*, 17(6), ss. 819-840. Riksidrottsförbundet. (2009). *Idrotten vill - idrottsrörelsens idéprogram*. Stockholm: Riksidrottsförbundet. SOU 2008:59. *Idrottsstödsutredningen* (2008). *Föreningsfostran och tävlingsfostran: en utvärdering av statens stöd till idrotten: betänkande*. Stockholm: Fritze.

## **10:20 - 11:50**

### **Invited symposia**

#### **IS-PM11 ECSS - ACSM EXCHANGE SYMPOSIUM : THE MARATHON AND THE HEART - THE GOOD, THE BAD, AND THE UNKNOWN**

##### **TOO MUCH PRESSURE ON THE PUMP?**

Whyte, G., Roberts, W.

*Liverpool John Moores University*

Regular physical activity is good for health and heart. The marathon is popular in the running community with nearly 3,600 races around the world and over a half million finishes in the USA and 1.6 million finishes worldwide in 2012. This session will look at cardiovascular changes associated with long term endurance training at the bench and diagnostic imaging level and the latest in road race medicine to save lives on the street during races. Like medications, there is likely an optimal exercise "dose" for health that may differ for marathon participation. This session will look at the cardiovascular risks and changes associated with marathon participation on race day and the potential heart changes over the course of long term training. The session at heart related changes associated with long term endurance training including coronary artery calcification, myofibrosis, and conduction system changes (atrial fibrillation). In additions we will also discuss the risk of sudden cardiac arrest and current race related strategies to reduce sudden cardiac death during races.

##### **DYING ON THE STREETS?**

Roberts, W., Whyte, G.

*University of Minnesota*

Regular physical activity is good for health and heart. The marathon is popular in the running community with nearly 3,600 races around the world and over a half million finishes in the USA and 1.6 million finishes worldwide in 2012. There is much discussion surrounding the effects of marathon running on the heart; both acute and chronic. Are marathon runners dying in unexpected numbers during training and race participation? Are your highly active patients at increased risk for cardiac dysfunction or death? This session will look at cardiovascular changes associated with long term endurance training at the bench and diagnostic imaging level and the latest in road race medicine to save lives on the street during races. Like medications, there is likely an optimal exercise "dose" for health that may differ for marathon participation. This session will look at the cardiovascular risks and changes associated with marathon participation on race day and the potential heart changes over the course of long term training. There is concern that long term endurance training and marathon running may "overdose" the heart and lead to pathological coronary artery calcification levels, myofibrosis, and conduction system changes (atrial fibrillation). There is also the risk of exercise associated collapse with sudden cardiac arrest, and the session will address current race related strategies to reduce sudden cardiac death during races.

## Invited symposia

**IS-PM04 EFFECTS OF EXERCISE ON BRAIN FUNCTION, LEARNING AND MEMORY****NEURAL EFFECTS OF EXERCISE ON LEARNING AND PROBLEM SOLVING IN THE INTACT AND BRAIN INJURED INDIVIDUAL**

Mogensen, J.

*University of Copenhagen*

Cognitively enhancing effects within such domains as learning, memory and problem solving have been found in intact individuals as well as after traumatic and vascular brain injury. Such effects have been demonstrated in humans as well as in animal models – although the vast majority of well documented results have been obtained using experimental animals. Within animal models addressing effects of physical exercise on cognitive recovery after brain injury focus has been on: (A) Identifying the neural mechanisms mediating such clinically relevant effects and (B) identification of the optimal parameters for obtaining therapeutic effects. Exercise influences a vast spectrum of neural processes. But increased production of neurotrophins appears to play a central role in recovery-promoting processes. Especially increased transcription of Brain Derived Neurotrophic Factor (BDNF) has been shown to be at least one of these mechanisms. Attempting to identify the optimal parameters for enhancement of posttraumatic cognitive recovery the focus has primarily been on: (1) The timing of initiation of exercise – soon/immediately after infliction of injury or at a later time-point? (2) The optimal intensity of exercise. And (3) whether the exercise should be voluntary or forced – relatively stress-free or associated with stressful processes? Within all of these research areas results remain contradictory. This lack of a cohesive understanding may primarily be due to methodological issues. For instance, the literature contains inconsistencies regarding factors such as the type of injury as well as the cognitive parameters used to evaluate potential cognitive enhancing effects.

**EPIDEMIOLOGICAL STUDIES OF THE IMPORTANCE OF CARDIOVASCULAR FITNESS FOR COGNITIVE ABILITY AND NEUROPROTECTION.**

Aberg, M.

*Institute for Neuroscience and Physiology*

Background: Cardiovascular fitness is associated with positive effects on multiple aspects of brain function and cognition. Studies report benefits of long-term, regular physical activity on later cognition and brain health. However, several of these studies have relatively short follow-up times or lack objective measures by relying on self-reported questionnaires. Objectives: To determine whether physical exercise at 18 years of age, as indexed by cardiovascular fitness, is associated with cognitive performance; to determine whether cardiovascular fitness at 18 years of age predicts future cognitive achievements and future risk of mental illness, epilepsy, stroke and early-onset dementia. Material/Methods: We performed a population-based, cohort study of over 1.1 million Swedish male conscripts who were followed for up to 42 years. Data on cardiovascular fitness and cognitive performance were collected during conscription exams and linked with the Swedish Twin Register, national databases for information on school achievement, socioeconomic status and hospital registers to calculate later risk of mental illness, epilepsy, stroke and early-onset dementia using Cox proportional hazards models controlling for several confounders. Results: We have shown in twin models that physical fitness and cognitive ability at 18 years of age are positively correlated and that the association is not determined by genetic factors (Åberg et al., 2009). Our data also demonstrate that poorer physical fitness at 18 years of age leads to an increased risk of depression, suicide, epilepsy, stroke and dementia later in life (Åberg et al., 2012, Åberg et al., 2014, Nyberg et al., 2013, Nyberg et al., 2014). The highest risks were observed for individuals with a combination of low cardiovascular fitness and cognitive performance. Conclusion: These findings indicate the importance of cardiovascular exercise during adolescence for cognitive capabilities and future brain health. From a public health perspective and from a lifetime perspective the issues of how physical activity, fitness and IQ are related over time to cognition and neuroprotection are central to obtain answers for, so that we can have a good basis for future prevention and intervention.

**EFFECTS OF EXERCISE INTERVENTIONS ON HUMAN MOTOR LEARNING, COGNITIVE FUNCTIONS AND MEMORY**

Lundbye-Jensen, J.

*University of Copenhagen*

The positive effects which cardiovascular exercise may have on several aspects of cognitive functioning are well established. During the recent years, there has been an increasing focus on neuroplasticity and on the processes that support memory formation and learning and several studies documented positive interactions between exercise, memory and learning. However, the mechanisms underlying the effects of exercise on human memory and learning remain controversial. Several studies have attempted to identify potential modulators that could explain the divergent responses to cardiovascular exercise in improving both declarative and nondeclarative memory as seen in motor learning. For example, there has been an emerging interest in understanding how specific parameters of exercise such as intensity might influence the effects on memory. One important but commonly neglected parameter that is essential for memory formation processes is the timing of exercise. I present data supporting the hypothesis that the effects of cardiovascular exercise on memory are not only intensity but also time-dependent. The results encompass studies focusing primarily on the effects of acute exercise on mechanisms involved in motor learning but results from longitudinal studies are also presented. In addition to effects of exercise on memory, the longitudinal studies also include effects of exercise on cognitive functions and academic performance e.g. in children. We argue that strategically scheduled exercise performed in close proximity to learning sessions may promote the effects of exercise on learning and memory in part through an effect on consolidation. Reference List 1. Skriver K, Roig M, Lundbye-Jensen J, Pingel J, Helge JW, Kiens B, Nielsen JB (2014) Acute exercise improves motor memory: exploring potential biomarkers *Neurobiol Learn Mem.* 2014 Dec;116:46-58. 2. Roig M, Nordbrandt S, Geertsens SS, Nielsen JB. (2013) The effects of cardiovascular exercise on human memory: a review with meta-analysis. *Neurosci Biobehav Rev.* 2013 Sep;37(8):1645-66. 3. Roig M, Skriver K, Lundbye-Jensen J, Kiens B, Nielsen JB. (2012) A single bout of exercise improves motor memory. *PLoS One.* 2012;7(9):e44594

## Invited symposia

**IS-PM03 FEMALE SEX HORMONES AND SKELETAL MUSCLE \*****HORMONE REPLACEMENT THERAPY – EFFECT ON MUSCLE MASS AND MUSCLE FUNCTION**

Sipilä, S.1, Finni, T.2, Pöllänen, E.1, Kovanen, V.1

*University of Jyväskylä*

**Introduction** Cross-sectional studies suggest that the accelerated decline in neuromuscular function with aging occurs earlier in women than in men (Phillips et al 1993). Hormonal changes during menopausal transition may be among the underlying factor for this early decline in women. Hormone replacement therapy (HRT) has successfully been used to treat symptoms which are unquestionably caused by estrogen deficiency. Knowledge on the role of estrogen deficiency and the effects of HRT on neuromuscular system in peri- and post-menopausal women is, however, inconsistent. The purpose of this presentation is to summarize the results of our studies investigating the role of HRT on neuromuscular function in women at their early postmenopausal years. **Methods** A year-long randomized controlled trial included 80 women aged 50–57 yrs randomized in 4 study groups; HRT (estradiol 2mg and norethisterone acetate 1mg), exercise (EX), HRT+EX and control (CO). A twin study included 15 MZ 54–62-year-old twin pairs discordant for HRT for on average of 7 yrs. Muscle mass and composition (CT scanning) and neuromuscular function (muscle force, twitch torque, power, walking and running speed) were measured (Finni et al 2011, Ronkainen et al 2011, Sipilä et al 2001). Gene expression of IGF-1 signaling pathway was assessed from muscle biopsies using microarray data (Illumina Inc., San Diego, CA) (Pöllänen et al 2010, Ronkainen et al 2010). **Results** Both studies showed that HRT is beneficial for neuromuscular function. We observed 14-16% greater muscle power, 32% greater plantar flexion twitch torque and 2-7% greater running and maximal walking speed in HRT users compared to non-users. No difference between the twin sisters was observed in habitual walking speed or voluntary isometric force. HRT had favourable effects on muscle mass and composition. Twin sister on HRT had 28% greater expression of IGF-1 receptor than their co-twins not on HRT. HRT significantly upregulated expression of IGF-1, IGF-1Ec, androgen receptor, FOXO3 and mTOR and down regulated AKT1 compared to CO. **Discussion** HRT has beneficial effects on neuromuscular system and function in women during their early postmenopausal years, especially in activities with higher contraction velocity. IGF-1 signaling pathway is among the biological mechanisms underlying beneficial effects of HRT in skeletal muscle. **References** Finni et al. (2011). *Muscle Nerve*, 44(5),769-75. Phillips SK et al. (1993). *Clin Sci (Lond)*,84(1), 95-8. Pöllänen E et al. (2010). *Growth Horm IGF Res*,20(5), 372-9. Ronkainen et al. (2009). *J Appl Physiol*,107(1),25-33. Ronkainen et al. (2010). *Aging Cell* 9(6),1098-110. Sipilä S. et al. (2001). *Clin Sci*, 101(2),147-57. Contact Sarianna.sipila@jyu.fi

**ORAL CONTRACEPTIVES – EFFECT ON SKELETAL MUSCLE AND TENDON PROTEIN TURNOVER AND BIOMECHANICAL PROPERTIES**

Hansen, M.

*Aarhus University*

**Introduction** Use of oral contraceptives (OC) is wide-spread especially among young women. Nevertheless, the knowledge regarding the effect of OC on skeletal muscle is sparse. In this presentation the recent literature on the effect of OC on skeletal muscle and tendon will be presented. The focus will be on muscle and tendon protein turnover, muscle mass, tendon structure and tendon biomechanical properties. Furthermore, the association between OC use and injury risk will be discussed. **References** Hansen M & Kjaer M. (2014). *Exerc Sport Sci Rev*, 42(4), 183-92 Hansen M, et al. (2013). *J Appl Physiol*, 114(8), 998-1008. Hansen M, et al. (2011) *Scand. J Med Sci Sports*, 21(1), 62-72 Contact mhan@ph.au.dk here

**ESTROGEN REPLACEMENT AND SKELETAL MUSCLE: MECHANISMS AND POPULATION HEALTH**

Tiidus, P.

*Wilfrid Laurier University*

**Introduction** Using an ovariectomized rodent model we have demonstrated that as well as enhancing antioxidant and anti-inflammatory properties, estrogen replacement will augment post-exercise muscle satellite cell activation and proliferation. This effect may explain some of the ability of estrogen replacement in post-menopausal women to maintain and enhance muscle mass and function. Our more recent research has also demonstrated the influence of muscle estrogen receptors and the PI3K-Akt signalling pathway as physiological mechanisms by which estrogen will induce this augmentation of muscle satellite cell responses to exercise. In addition, we will present new data on the influence of estrogen on muscle Heat shock protein expression as well as the negative effects of a post-ovariectomy delay in estrogen replacement on post-exercise muscle satellite cell proliferation using our rodent model. Implications of these effects for muscle function in older human females will be also discussed. Finally, some of the health issues associated with hormone replacement therapy in post-menopausal women will be noted. **References** Mangan G. et al. (2014). *Acta Physiol*, 212, 75-85 Tiidus PM, et al. (2013). *J Appl Physiol*, 115, 569-578. Bombardier E, et al. (2013) *Can J Physiol Pharmacol*, 91, 823-829 Thomas A, et al. (2010) *Acta Physiol*, 198, 81-89 Enns DL & Tiidus PM (2010) *Sports Med*, 40, 41-58 Contact ptiidus@wlu.ca

## Oral presentations

### OP-PM16 Physiology: Fatigue

#### PACING DIFFERS BETWEEN TIME- AND DISTANCE-BASED TRIALS

Abbiss, C.R., Thompson, K.G., Lipski, M., Meyer, T., Skorski, S.

*Edith Cowan University*

**Introduction:** An important aspect of pacing is the ability of an individual to make prospective judgments about the demands of a task (Chinnasamy et al. 2013) and momentary (De Koning 2011) or anticipated physiological/metabolic stress (Tucker et al. 2004). Both time- and distance-based time trials (TT) are often implemented to assess pacing and performance. One's ability to judge time and distance is likely to influence anticipated task demands and thus pacing (Chinnasamy et al. 2013). The purpose of this study was to compare pacing and performance between distance- and duration-based trials of short (~6 min) and long (~30 min) duration. **Methods:** On separate occasions and in a randomised semi-balanced order, 13 trained cyclists (4 female, 9 male; mass:  $74 \pm 9$  kg,  $VO_{2max}$ :  $55.1 \pm 3.9$  ml/kg/min) completed four self-paced cycling time trials (TT; 4 km, 20 km, 6 min and 30 min). Duration and distance of TTs was chosen to approximately match the total work during short (4 km and 6 min) and long (20 km and 30 km) TTs. Participants were instructed to complete each time trial with the highest sustainable power output. Distance/duration covered was the only feedback provided. **Results:** Average power output was not different between the 4 km and 6 min TTs ( $324 \pm 46$  vs  $325 \pm 45$  W;  $P=0.96$ ), nor the 20 km and 30 min TTs ( $271 \pm 44$  vs  $267 \pm 38$  W;  $P=0.24$ ). Exercise time was lower during the 4 km TT (min:s;  $5:40 \pm 0:18$ ) compared with the 6 min TT ( $P=0.01$ ) but not different between the 20 km ( $29:51 \pm 1:45$ ) and 30 min trial ( $P=0.77$ ). There was also no significant trial by split interaction for the short or the long TTs ( $P=0.74$  and  $0.15$ , respectively). The rate of decline in power output over the first 40% of the trial was not different between the 4 km and the 6 min TT ( $P=0.13$ ), but was greater in the 20 km TT compared with the 30 min TT ( $P=0.01$ ). **Discussion:** Pacing within short trials was similar however, athletes commenced a longer distance-based TT at relatively higher power outputs when compared with a similar time-based trial. This contrasts findings in children where lower running speeds have been observed in the final stage of a time- compared with distance-based task (Chinnasamy et al. 2013). These findings indicate that pacing differs between prolonged distance- and time-based tasks which may be related to the athletes' anticipation of task demands. **References:** Chinnasamy C, St Clair Gibson A, Micklewright D (2013). *Med Sci Sport Exerc.* 45(2), 395-402. Tucker R, Rauch L, Harley YXR, Noakes TD (2004). *Eur J Physiol.* 448, 422-430. De Koning JJ, Foster C, Bakkum A, Kloppenburg S, Thiel C, Joseph T, Cohen J, Porcari JP(2011). *PLOS One.* 6(1): e15863

#### THE EFFECT OF A SLEEP HYGIENE PROTOCOL ON PHYSICAL RECOVERY FOLLOWING A LATE-NIGHT MATCH IN FOOTBALL PLAYERS

Fullagar, H.H.K.1, Skorski, S.1, Duffield, R.2, Meyer, T.1

*(1) Saarland University, Germany (2) University of Technology Sydney, Australia*

**Introduction** Late-night matches are a common occurrence for elite footballers and can result in sleep disruption, which is often highlighted as a cause of slower recovery (Meyer et al. 2014). Sleep hygiene protocols (SHP) have been suggested to aid sleep quantity/quality (Duffield et al. 2014) and therefore may assist ensuing recovery from late-night finishes. However, the effectiveness of SHP to improve recovery following these matches remains unknown. Therefore, this study aimed to investigate the effects of a SHP on physical recovery following late-night matches in football players. **Methods** In a randomised cross-over trial, 20 male ( $179 \pm 6$  cm;  $75.6 \pm 7.4$  kg;  $25 \pm 4$  y) well-trained football players from 2 teams played two friendly matches against one another with late-night kick-offs (20:45), seven days apart. Following each match, players either completed a SHP (Duffield et al. 2014) with bed time before 12:00am or remained awake without sleep protocols (NSHP) until 02:00 (objective sleep data collected). Players were awoken at 07:30 the next morning. Post-match recovery measures (Counter-movement jump (CMJ) and YoYoIR2 (YYIR2) tests were obtained 12 h and 36 h post-match. **Results** Mean±SD time of sleep for SHP and NSHP was  $12:22am \pm 26$  min and  $02:30am \pm 13$  min, respectively. Sleep duration was significantly greater ( $P < 0.01$ ) in the SHP group ( $372 \pm 46$  min) compared to the NSHP condition ( $266 \pm 27$  min). No significant differences were found between conditions for CMJ for 12 h (NSHP:  $35.3 \pm 3.9$  cm; SHP:  $35.9 \pm 3.8$  cm) and 36 h (NSHP:  $35.2 \pm 3.9$  cm; SHP:  $34.8 \pm 3.6$  cm) post-match ( $P=0.13$  and  $0.33$ , respectively). Further, no significant differences were found between conditions for YYIR2 for 12 h (NSHP:  $627 \pm 153$  m; SHP:  $606 \pm 131$  m) and 36 h (NSHP:  $630 \pm 152$  m; SHP:  $600 \pm 155$  m) post-match ( $P=0.13$  and  $0.44$ ). **Discussion** Whilst SHP improved sleep quantity by around 2 h following a late-night football match, there were no improvements in acute physical recovery. The lack of an effect on recovery may be possibly due to not having a large enough absolute sleep difference between conditions, albeit the bedtime in the NSHP condition is similar to reported match bedtimes in professional players. Further, our matches were friendlies limiting the inference of our results to competitive matches (different physical/psychological loads). Thus, future research may be directed towards whether a larger differential in sleep duration can improve the recovery timeline. In addition, evidence concerning responses to sleep interventions following actual competitive matches in professional players is required. **References** Meyer T, et al. *Sport Orthop Traumatol.* 2014;30:112-8. Duffield R, et al. *Int J Sport Physiol Perform.* 2014; 9(2):273-82. Contact [hugh.fullagar@uni-saarland.de](mailto:hugh.fullagar@uni-saarland.de)

#### EFFECT OF PROGRESSIVE NORMOBARIC HYPOXIA ON DYNAMIC CEREBRAL AUTOREGULATION

Horiuchi, M., Endo, J., Dobashi, S., Kiuchi, M., Koyama, K., Subudhi, A.W.

*Mt. Fuji Research Institute*

**Introduction** Previous studies have shown impairments in dynamic cerebral autoregulation (CA) during acute periods (~10) of severe, but not moderate, hypoxia (1). These findings have led to speculation that a threshold level of hypoxia must be exceeded before CA is impaired. We sought to determine the threshold of hypoxia necessary to impair CA. **Methods** Six healthy young men with a mean age of  $22 \pm 3$  years (mean ±SD), height of  $175 \pm 5$  cm, and body weight  $64 \pm 4$  kg, were studied at an elevation of 3000 m ( $P_{bar} = 735$  mmHg). Subjects were exposed to progressive levels of normobaric hypoxia (30 min stages inspiring 21, 18, 15, and 12% O<sub>2</sub>). At each level of hypoxia, dynamic CA was evaluated twice (?) using the classic thigh-cuff inflation (3 min at 220 mmHg) / rapid deflation technique to induce a transient drop in arterial blood pressure. Common carotid artery (CCA) blood flow and beat-by-beat blood pressure were measured throughout the study. Rate of regulation (RoR) as an indicator of dynamic CA was calculated from the slope of CCA conductance (CCA blood flow/blood pressure) from 1.0~4.0 s after thigh cuff-release, relative to the drop in mean arterial pressure (MAP);  $RoR = (\Delta CCA$

conductance / delta t) / delta MAP. Results RoR was unchanged from 21 % to 18 % O<sub>2</sub> (include RoR values respectively, P>0.05), but was impaired at 15 % and 12 % O<sub>2</sub> (include RoR values, respectively) when compared against 21 % and 18 % O<sub>2</sub> (P<0.05). Progressive hypoxia from 15 to 12 % O<sub>2</sub> did not further reduce RoR (P>0.05). Discussion Our results indicate that the hypoxic threshold for impairment in dynamic CA occurs at ~15 % O<sub>2</sub> (PIO<sub>2</sub> of 560 mmHg). Our findings are in agreement with a previous study, which utilized shorter periods of hypoxia (~10 min) and transfer function analysis to assess CA. These studies suggest that dynamic CA impairment may be seen at elevations where the PIO<sub>2</sub> is similar. Future field studies are necessary to confirm these findings and study the implications of impaired CA at higher elevations. References 1. Iwasaki et al. (2007) *J Cereb Blood Flow Metab*, 27: 776-784. 2. Van Osta et al. (2005) *Stroke*, 36: 557-560. 3. Subudhi et al. (2010) *Stroke*, 41: 641-646.

## ENDURANCE EXERCISE INCREASES PLASMA KYNURENIC ACID IN HUMANS

Schlittler, M.

*Karolinska Institutet*

**INTRODUCTION** The kynurenine pathway of tryptophan degradation generates several neuroactive metabolites, such as quinolinic acid (QUIN; a glutamate agonist) and kynurenic acid (KYNA; a glutamate antagonist). Induction of the neurotoxic branch, leading to excess of QUIN has been associated with depression (1). Exercise training may protect from depression by an increased expression of skeletal muscle kynurenine amino-transferases (KATs), which convert plasma kynurenine to KYNA and thus prevent metabolism towards QUIN (2). The aim of this study was to analyse plasma KYNA in humans at rest and following different types of exercise. **METHODS** Blood samples were drawn from athletes before and after (1h and 24h) aerobic endurance exercise (150 km road cycling or 21.1 km running). Results were compared to another group of athletes performing high-intensity eccentric exercise (100 drop-jump) as well as to a group of inactive subjects (non-athletes). In all samples, plasma was analysed for KYNA by high-performance liquid chromatography with fluorescence detection. **RESULTS** In the athletes performing endurance exercise, KYNA concentration increased significantly 1 hour after endurance exercise compared to baseline. The concentration of KYNA returned to baseline 24 hours after exercise. Plasma concentration of KYNA was not affected by the high-intensity eccentric exercise. Plasma KYNA concentrations of inactive subjects were similar to those of the athletes before exercise. **DISCUSSION** Our data indicate that plasma KYNA concentration increases following endurance exercise but not after high-intensity eccentric exercise. Endurance exercise may thus cause a peripheral shift in the kynurenine pathway that could be protective against depression. In high-intensity eccentric exercise, which causes muscle damage and severe fatigue but is less metabolically challenging than the endurance exercise, plasma KYNA did not increase. This suggests that activation of the kynurenine pathway in exercise is linked to metabolic demand. **REFERENCES** 1 Claes, S. et al. The kynurenine pathway in major depression: haplotype analysis of three related functional candidate genes. *Psychiatry research* 188, 355-360, doi:10.1016/j.psychres.2011.03.012 (2011). 2 Agudelo, L. Z. et al. Skeletal muscle PGC-1alpha1 modulates kynurenine metabolism and mediates resilience to stress-induced depression. *Cell* 159, 33-45, doi:10.1016/j.cell.2014.07.051 (2014).

## EFFECTS OF ACUTE DIGOXIN INTAKE ON SKELETAL MUSCLE NA<sup>+</sup>,K<sup>+</sup>-ATPASE CONTENT, PLASMA K<sup>+</sup> REGULATION AND FATIGUE DURING INTENSE EXERCISE IN HEALTHY YOUNG ADULTS

Atanasovska, T., Smith, R., Wong, C., Petersen, A.C., Krum, H., McKenna, M.J.

*Victoria University, Melbourne, Victoria, Australia*

Potassium (K<sup>+</sup>) disturbances during intense exercise have been linked with fatigue. We investigated the effects of acute administration of digoxin, a specific Na<sup>+</sup>,K<sup>+</sup>-ATPase (NKA) inhibitor, on K<sup>+</sup> regulation, exercise performance and skeletal muscle NKA content and isoform abundance, in 10 healthy adults, in a randomised, crossover, double-blind, counterbalanced design study. Participants were orally administered 50 mg digoxin (DIG) or placebo (PLAC) and then 60 min later commenced cycling for 1 minute at 60% and 95%VO<sub>2peak</sub>; then to volitional fatigue at 95%VO<sub>2peak</sub>. Radial arterial plasma [K<sup>+</sup>]<sub>a</sub> was measured at rest, during exercise, for up to 60 min in recovery. A vastus lateralis muscle biopsy was performed at rest and immediately post-exercise and analysed for NKA content via [3H]-ouabain binding, without and with digoxin antibody DigiF(ab)<sup>®</sup> to detect the fraction of NKA bound by digoxin; and for NKA isoform protein abundance. Serum digoxin concentration prior to exercise was 3.36±0.80 nM in DIG (below 0.2 nM detection limit in PLAC). Time to fatigue at 95%VO<sub>2peak</sub> was 6.4% less during DIG than PLAC (233.7±46.0 vs 249.8±53.3, respectively, P=0.029). Muscle NKA content as determined by [3H]-ouabain binding was unchanged with DIG; but separate [3H]-ouabain binding analysis after removal of bound digoxin with DigiF(ab)<sup>®</sup> antibodies revealed a 7.8% digoxin occupancy compared to PLAC (P=0.003), indicating a 7.8% increase in actual muscle NKA content after DIG. The NKA α-1 and β-2 isoform protein abundances were unchanged with digoxin. Plasma [K<sup>+</sup>]<sub>a</sub> increased during exercise and fell immediately in recovery, being lower than baseline at 10 min post-exercise (P=0.025). Plasma [K<sup>+</sup>]<sub>a</sub> was greater in DIG than PLAC across all times (4.93±0.18 vs. 4.88±0.20, respectively, P=0.035). Thus acute digoxin treatment increased the number of apparently functional NKA complexes, as detectable by the 7.8% increase in [3H] ouabain binding after DigiF(ab)<sup>®</sup> pre-treatment, which occurred in the absence of any increase in α or β isoform abundances. This may indicate that acute digoxin-inhibition of NKA stimulated increased assembly of existing α and β subunits. This would act to rapidly recover the number of available NKA, thus preserving muscle NKA capacity in the face of acute NKA inhibition and consequent potential deleterious effects. Despite this, DIG perturbed arterial K<sup>+</sup> regulation and impaired muscle performance, with increased fatigability during intense exercise.

## Invited symposia

### IS-BN02 SPORT EXPERTISE: PUTTING BRAIN, BODY, AND ENVIRONMENT TOGETHER AGAIN

#### EXPERTS EXPLOIT NEUROBIOLOGICAL DEGENERACY IN MULTI-ARTICULAR SKILLS

Seifert, L.

*University of Rouen*

This talk identifies key properties of expertise in sport predicated on the performer-environment relationship. Weaknesses of traditional approaches to expert performance, which uniquely focus on the performer and the environment separately, are highlighted by an ecological dynamics perspective. Key properties of expert movement systems include degeneracy, multi- and meta-stability, adaptive varia-

bility and the attunement to affordances (Seifert et al., 2013). Empirical research on these expert system properties indicates that skill acquisition does not emerge from the internal representation of declarative and procedural knowledge, or the imitation of expert behaviours to linearly reduce a perceived 'gap' separating movements of beginners and a putative expert model. Rather expert performance corresponds with the ongoing co-adaptation of an individual's behaviours to dynamically changing, interacting constraints, individually perceived and encountered. The functional role of adaptive movement variability is essential to expert performance in many different sports, showing how many coordinative structures can achieve the same function (i.e., performance outcome), which is known as degeneracy property (Edelman and Gally, 2001; Friston and Price, 2003). This key property signifies that, in sport performance, although basic movement patterns need to be acquired by developing athletes, there exists no ideal movement template towards which all learners should aspire, since relatively unique functional movement solutions emerge from the interaction of key constraints (Davids et al., 2015). In this talk, a special focus on degeneracy property is provided to highlight how expert functionally explore and interact with their environment in climbing (Seifert et al., 2014). References Davids, K., Araújo, D., Seifert, L., Orth, D., 2015. Expert performance in sport: An ecological dynamics perspective. In: Baker, J., Farrow, D. (Eds.), *Handbook of Sport Expertise*. Taylor & Francis, London, UK, pp. 273–303. Edelman, G.M., Gally, J. a, 2001. Degeneracy and complexity in biological systems. *Proc. Natl. Acad. Sci. U. S. A.* 98, 13763–8. Friston, K.J., Price, C.J., 2003. Degeneracy and redundancy in cognitive anatomy. *Trends Cogn. Sci.* 7, 151–152. Seifert, L., Button, C., Davids, K., 2013. Key properties of expert movement systems in sport : an ecological dynamics perspective. *Sports Med.* 43, 167–78. Seifert, L., Wattedled, L., Hérault, R., Poizat, G., Adé, D., Gal-Petitfaux, N., Davids, K., 2014. Neurobiological Degeneracy and Affordance Perception Support Functional Intra-Individual Variability of Inter-Limb Coordination during Ice Climbing. *PLoS One* 9, e89865.

### **ACTION ANTICIPATION AND ACTION PLANNING IN ELITE ATHLETES: EVIDENCES FROM PSYCHOPHYSICS AND TRANSCRANIAL STIMULATIONS STUDIES**

Cesari, P.

*University of Verona*

Although behavioral studies suggest that professional athletes have better sensory and motor skills than novices, very little is known about the neural underpinnings of these superior perceptuo-motor abilities. Elite sports performance not only involves the ability to execute complex actions such as, for example, shooting a ball into a basket, but also the ability to predict and anticipate the behavior of other players. Thus, observing others' actions may imply a covert simulation of the very same action, a process likely crucial in both imitative and non-imitative motor learning. One may wonder whether the modulation of resonant action systems has any specific role in the superior perceptual abilities exhibited by athletes engaging in sports activity. Here we present several experiments showing the exceptional ability that basketball and soccer players along with professional dancers have in pre-programming and in anticipating the actions in which they excel.

### **AN ECOLOGICAL DYNAMICS VIEW OF SOCIAL COORDINATION: GOING BEYOND A TEAM OF EXPERTS TOWARDS AN EXPERT TEAM**

Araujo, D.

*University of Lisbon*

Previous research has proposed that team coordination is based on shared knowledge of the performance context, responsible for linking teammates' mental representations for collective, internalized action solutions. However, we argue that the traditional shared knowledge assumption is predicated on "knowledge about" the environment, which can be used to share knowledge and influence intentions of others prior to competition. Rather, during competitive performance, the control of action by perceiving surrounding informational constraints is expressed in "knowledge of" the environment. This crucial distinction emphasizes perception of shared affordances (for others and of others) as the main communication channel between team members during team coordination tasks. From this perspective, the emergence of coordinated behaviours in sports teams is based on the formation of interpersonal synergies between players resulting from collective actions predicated on shared affordances. We highlight innovative measurement tools which might be used in research and practice to capture such interpersonal synergies. These tools are suitable to reveal the idiosyncratic collective behaviours of sports teams, particularly their coordination of effort and the more frequent patterns of communication and interactions between team players. More to the point, we will address three properties of synergies and the tools that could measure each of them. For example, dimensional compression could be measured by cluster phase; Sharing patterns could be measured by dominant regions; and reciprocal compensation could be measured by social complex networks.

## **Invited symposia**

### **IS-BN03 THE WORKPLACE AS ARENA FOR HEALTH ENHANCING PHYSICAL ACTIVITY INTERVENTIONS. QUANTIFICATION AND HOW TO REACH THOSE MOST IN NEED**

#### **DESIGNING WORKPLACE PHYSICAL EXERCISE TRAINING INTERVENTIONS TAILORED TO OCCUPATIONAL EXPOSURE.**

Søgaard, K.

*Institute of Sports Science and Clinical Biomechanics*

Introduction Physical exercise at the workplace is a key factor in managing musculoskeletal pain, improving health and decreasing risk factors for lifestyle diseases. Many studies have focused on the effect of physical exercise among office workers, while the evidence for employees with physically heavy work is more scarce. This is an interesting paradox since the latter sectors presents with the largest prevalence of musculoskeletal pain and life style diseases in general. The employees in these sectors are thus most in need of and have the largest potential to benefit from physical exercise programs. The emerging interest in sedentary lifestyle, including inactivity in working time, as a risk factor has logically also increased focus on physical exercise as the general tool that can be used to counteract lifestyle diseases and the work place as the setting. However, in many occupational sectors the employees still have a relatively high physical workload, which in contrast to leisure time physical activity may not be health enhancing. Rather, occupational physical activity consists of many different elements, some of them, but not all, usually considered risk factors for mechanical, metabolic and cardiorespiratory

overload. Thus high static loads such as in frequent lifting may constitute a risk factor while dynamic work involving walking or standing to some degree may maintain aerobic fitness. This involves a special challenge when introducing health enhancing physical activity among workers with physically heavy work. The challenge may be met by a thorough analysis of the work exposure as well as the capacity of the workers. This will form the basis for a sound exercise profile tailored to different occupational sectors and combining optimal ergonomics adjustment of the working conditions with physical exercise training. The same basic principles may apply both in sedentary and physically heavy jobs as the relation between the exposure and the effect forms a U-shape with an optimum exposure for obtaining the largest physiological benefit in terms of tissue growth, strength and general function. The concept of "Intelligent Physical Exercise Training" has been developed to tailor exercise to individual capacities and disorders, balancing capacity relatively to occupational exposure. For successful implementation, the concept strives to allow for flexibility in time scheme and location as well as to consider preferences of the participant to keep motivation high and in addition be as cost-effective for the company as possible. In this presentation an overview will be given of a number of recent Danish interventions involving more than 2000 employees and targeting both job sectors with physically heavy and more sedentary jobs.

#### **'OCCUPATIONAL PHYSICAL ACTIVITY – QUANTITY AND ROLE IN A HEALTH PERSPECTIVE**

Ainsworth, B.

*Arizona State University*

Physical activity at work is difficult to quantify but it represents an important part of the total daily energy expenditure. Thus, precise measures of occupational physical activity are needed to estimate the contribution of work behaviors to health and the risks of a number of life style diseases. Historically, epidemiologists have used job titles and job classification systems as a proxy for differences in occupational physical activity demands. They have compared those classifications with health outcomes. An improved estimation of occupational demands can be provided by assigning MET values to job tasks and classification systems. This method provides an inexpensive and feasible approach for quantification of occupational physical activity by intensity and estimation of work-related energy expenditure. Yet, as job demands and job titles change over time and increased emphasis is placed on the impact of sedentary behaviors on health, the MET classifications and occupational PA assessment methods must be updated to cover the content of today's occupations. This contribution will describe the methods and rationale for assigning MET estimates to occupational classification systems. Population estimates are presented for intensities of occupational activity to illustrate the use of the MET classification of occupational physical activity and thereby to quantify the relative contribution of this fraction to total physical activity, which may be of importance in a public health perspective.

#### **WORKPLACE PHYSICAL ACTIVITY INTERVENTIONS IN A COST-EFFECTIVENESS PERSPECTIVE.**

van der Beek, A.J., van Mechelen, W.

*EMGO Institute for Health and Care Research, VU University Medical Center*

From a number of perspectives, worksite health promotion programs seem to be relevant and might be even more effective than usual care regarding typical health risk factors, such as reductions in musculoskeletal disorders, body weight, cholesterol level, and cardiovascular disease risks. However, if the company should take a serious interest in such costly health enhancing initiatives, they should also be informed about side-effects on productivity, sick leave, and the overall economical aspect of a sustainable work force. Hence, the financial benefits related to these issues should be included in scientific evaluations, and the costs of the program should be minimized. This presentation will not only cover the aspect of the general benefit of the society related to primary prevention, but will also take the perspective of specific interest of the companies for such work-related health enhancing programs. Starting from the systematic review of J.M. van Dongen et al. (*Obes Rev* 2011;12:1031-49), an overview will be given of the scientific evidence that has been published since then, about the financial return of worksite health promotion programs aimed at improving nutrition and/or increasing physical activity.

### **Invited symposia**

#### **IS-SH04 RELATIVE AGE EFFECTS IN YOUTH SPORT: INSIGHTS FROM PHYSIOLOGICAL, PSYCHOLOGICAL, AND SOCIOLOGICAL PERSPECTIVES**

##### **RELATIVE AGE EFFECTS - A PSYCHOLOGICAL PERSPECTIVE**

Cobley, S.

*Sydney University*

In childhood and youth sport, discrepancies between the relatively older and younger participating on school, local, regional representative, and national sport teams can often vary between ratios of 1.5 to > 9 – 1. But as an outcome, these RAE effect sizes likely occur as a result of numerous interacting factors and social processes that span from the broad developmental system to the individual. For instance, RAEs likely relate to cognitive bias, whereby sports systems and practitioners apply errorful heuristics of 'availability, representativeness, escalation, and attribute substitution'. In contexts espousing and enacting a social-cultural focus upon 'domination and winning', essentially emulating the adult-elite sporting world, the conditions are set to identify and select players who can achieve those immediate outcomes (i.e., the relatively older and more physically mature). In this sense, practitioners are selecting appropriately, but in another sense they - and the system - are either not aware or consciously considering the dynamics of growth and development from a longer-term performance standpoint. Likewise, the potential psycho-social, skill, and health benefits from sport participation are being undermined. To change these values and ideologies in youth sport systems (i.e., replacing heuristics with analysis, rationality, and logic) the presentation also highlights recent intervention work seeking to reduce and remove RAEs from evaluation and selection processes.

**THE RELATIVE AGE EFFECT FROM THE PHYSIOLOGICAL AND PERFORMANCE PERSPECTIVE**

Gil, S.M.

*University of the Basque Country (UPV/EHU)*

Most sports systems group athletes according to their chronological age. Thus, a selected date of birth, known as the cut-off-date, is used to group children into age-specific teams. This particular date of birth is the 1st of January in most European countries, but it may be a different one (i.e. 1st September). Thus, a child born soon after this cut-off-date will be almost 12 months older than another one born at the end of the same year. Nevertheless, they will play sports together. The term relative age refers to a person's age relative to that of their peers within the same annual group. This characteristic depends on the date of birth relative to the selection data used to place a child in a specific age group. The variations in age within an annual age group have been referred to as relative age differences, and its consequence as the relative age effect (RAE). As a result of the RAE, there is an overrepresentation of the participants born in the first months after the cut-off-date in many sports, particularly in soccer and hockey. But it has also been observed in basketball, handball, tennis, winter sports, rugby league, swimming and cricket. Moreover, it has been reported not only in Europe, but also in Brazil, Japan, America and Australia. It is well documented that the RAE is more relevant in high level sport, particularly in male squads. In this respect, 36-50% of highly selected and international male soccer players had been born within the first three months of the year. On the other hand, not only skill level, but also age seems to be important in the RAE. In fact, RAE appears to progressively increase with age from childhood to adolescence. Besides, in school sports the differences are not so large; however, it depends on the sport. Physical and physiological growth and maturation have been hypothesized several times as the underlying cause for the RAE. In order to clarify it, some studies have compared performance and fitness of youngsters and adolescents of the general population born in the different months of the year, demonstrating controversial results. On the other hand, it has been observed that some sports participants born in the beginning of the year are taller, heavier and they also perform better compared to those born towards the end of the year. In contrast, in highly selected squads the differences become smaller. The importance of this issue is relevant for two reasons: on one side, children born at the end of the year will not have the same opportunities to be selected to participate in higher level sports; on the other, from a more competitive point of view, there will be an inevitable loss of talent.

**RELATIVE AGE EFFECT FROM A SOCIOLOGICAL PERSPECTIVE**

Pettersson, T.

*Dep. of Sport Sciences*

The sports movements in the Scandinavian countries have, in an historical perspective, been comparatively well supported by the State. State support for youth leisure activities has been directed to different youth organizations, particularly sports clubs. Government grants to sport are given primarily because it fulfills through its various activities a number of goals which do not necessarily have to do with sports, but which society considers important to achieve by means of government funding. The resources are to be used to reach out to people and activate those who want to take part in organized sports or choose to do physical exercise for their own well-being. For sports clubs, however, fostering top athletes is an essential part of their pursuit. Selection systems believed to produce top athletes exists at all levels within the sports movements – local, regional and national. And selection systems cannot be used without the appearance of Relative Age Effects. RAEs have been suggested as representing a form of bias, irrationality, and are counter-productive to longer-term attainment and the motives of the State to support youth sport. In the long run this could lead to the public acceptance of a generous tax-paid support to youth sport being jeopardized. Therefore we argue for the research community to engage with sport organizations and sport governing bodies to more strongly support child and youth longer-term development. We also believe in the importance of doing this using a multidisciplinary approach.

**Invited symposia****IS-SH09 SPORTS LABOUR MOBILITY AND THE POLITICS OF PRECARIY**

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**GLOBALIZATION, SPORTS AND THE PRECARIY OF MASCULINITY**

Besnier, N.

*University of Amsterdam*

Through the lens of multi-sited comparative ethnographic research on the hopes of young man in the Global South and the migratory actions that derive from them, the ERC-funded "Globalization, Sports and the Precarity of Masculinity" (2012–17) project seeks to shed light on a number of fundamental theoretical problems in the contemporary world: How masculinity articulates with the body, consumption, and the global condition; how it operates as a guide for social action in contexts in which poverty and marginality have seriously undermined the ability to hope; and how nationalism, citizenship, and belonging operate in a field in which global dynamics have seriously disrupted their taken-for-granted nature, while they simultaneously remain at the forefront of public debates. The project analyses the global condition through an understanding of gendered bodily practices, thus reversing common approaches that begin with large-scale processes as the frame for understanding sports labour migration. Furthermore, the project provides a critical and hitherto unexplored angle on themes that are of immediate concern to not only societies teetering on the edge of the global, but also to industrial societies that must engage with the Global South: "the predicament of youth," "the precarity of masculinity," and "the crisis" tout court.

**THE CIRCULATION OF BRAZILIAN FOOTBALL PLAYERS**

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The dissemination of Brazilian football players abroad, even if not recent, has heightened in the 21st century, presenting a large symbolic impact given its strong presence in the global media and the colonization of masculine imaginations exercised by football. In addition to the player-celebrities at global clubs in Europe, there is also a numerically significant flow of non-famous players who look for work in countries that are unlikely destinations for other Brazilian emigrants such as Russia, China, India, Korea and Morocco. There is also a



nearly invisible flow of Brazilian women football players who seek the United States and northern Europe countries to practice the sport in which they have been historically discriminated against in Brazil, as indicated by the closing of the women's football department at Santos, which had traditionally been Brazil's leading women's football club. Based on multi-site ethnographic research conducted since 2003 about the careers and lifestyles of Brazilian players living in more than 10 countries, I argue that categories such as frontier, migration, immigrant/emigrant and transnationalism do not apply to the mobilities of male and female football players. In the same way that in other professional trajectories, such as those of diplomats or intellectuals, these displacements are constituted in circulations beyond state borders, with periodic returns to the country of origin. I show that life abroad takes place in protected bubbles, where the relations of the protagonists are more translocal than transnational and that in recent years there has been a more accentuated return. o not insert authors here

### PRECARIOUS ISSUES IN WOMEN'S FOOTBALL MIGRATION

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The career of an international athlete is often characterized by short-term contracts and career uncertainties illuminating central aspects of contemporary labour migration and neo-liberal employment practices. The British economist, Guy Standing, has examined the process of becoming part of the 'precariat' combining the concepts precarious and proletariat. The defining characteristic of precariats is the unstable and short-term nature of their employment underpinned by a low probability of building a career. This presentation will be based on a critical case study of African female athletes' migration into and away from Scandinavian football clubs. First of all, the case study points to precarious issues relating to the processes through which athletes obtain labour mobility by moving to Europe and between European sports clubs. Secondly, precarious issues are found in relation to labour conditions and accommodation of migrant athletes in Scandinavia, and thirdly the case study points to precarious issues relating to life after the professional athletic career. Even if Scandinavian clubs and audiences employ and consume an increasing numbers of transnational athletes, there is no policy framework set up to ensure support to their dual career development and post-career transition. In other words, even if migrating female athletes certainly belong to the elite, there are many aspects of the market, profession and their job that may suggest comparing their options for upward mobility or secured existence with those of blue collar workers: giving your (physical) skills fully into the sports industry. However, the sports industry, its show business and, above all, the enactment of the game, also provide several options of self-realization and agency to their main social actors; the transnationally mobile player. The players themselves state that their primary motivation for moving is "the love of the game", which may be interpreted partly as a joy of being fully engaged in a game (that also is your main leisure interest) and, partly as an expression of the risks following with engaging yourself in the global labour market of sports. The presentation will address weaknesses in current policy provision that needs future societal and scientific attention.

## Oral presentations

### OP-PM38 Training & Testing: Endurance II

#### CORRELATION BETWEEN OXYGEN CONSUMPTION AND ACCELEROMETER COUNTS AT DIFFERENT PLACEMENTS DURING RUNNING

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Background - Measuring energy expenditure (EE) during free-living activities has received increasing interest from the research community (1). However, validity of EE measurements during exercise of higher intensities has proven difficult (2). Measuring EE using direct calorimetry (i.e., oxygen consumption; VO<sub>2</sub>) is the more accurate method but can be challenging to implement during free-living conditions (2). Therefore, triaxial accelerometers counts have been employed to quantify physical activity intensities and EE (3). Based on correlation analyses between accelerometer counts and EE, previous studies have shown that accelerometer counts underestimate EE during running at higher speeds (4, 5). Therefore, the purpose of this study was to investigate the correlations between vector magnitude (VM) counts and EE using alternative accelerometer placements during running. Methods - VO<sub>2</sub> (Oxycon Pro, Jaeger) was measured during progressive treadmill running starting at 8km/h with 2km/h increase every fourth minute until 18km/h with 30s brakes between each step. VM counts were measured with accelerometers (GT3X, ActiGraph) at 4 different sites (wrist, hip, thigh and ankle). VO<sub>2</sub> and VM counts from the last minute during each speed were analyzed. The subjects (N=14) were competitive triathletes/runners (1 female, 13 males) with an age (Mean±SD) of 28±8.2yr, mass 69.9±7.5kg and height 1.77±0.078m. Results - During progressive running, VM counts from the hand, ankle and thigh was strongly correlated with VO<sub>2</sub>/kg/min (wrist, thigh and ankle r<sup>2</sup> = 0.99), whereas VM counts from the hip-placed accelerometer showed poor correlation (hip r<sup>2</sup> = 0.02). Discussion - The current results confirm that VM counts underestimate EE during higher speeds of running using hip-placed accelerometers. In contrast, accelerometers placed on thigh, wrist and ankle all show excellent agreement between VM counts and EE. Previously, the plateau of VM counts reached during running at higher speeds using hip-placed accelerometers have been proposed to be a consequence of bandpass filtration (4). This explanation seems plausible, but it is unclear why this phenomenon was not present when accelerometers were placed at other sites. Further, equations is being constructed to predict EE from VM counts at the different accelerometer placements so future studies could investigate EE during free-living activities at various accelerometer placements. 1. J Sci Med Sport. 2011;14(6):504-11 2. Res Q Exerc Sport. 2000 Jun;71(2 Suppl):S30-6 3. J Aging Phys Act. 2010 Apr;18(2):158-70 4. Physiol Meas. 2012;33(2):219 5. Med Sci Sports Exerc. 2007 Jan;39(1):192-8

#### TEST PROTOCOL OPTIMIZATION OF THE HEART RATE-BASED LACTATE MINIMUM TEST

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Introduction: The knowledge of the maximal lactate-steady-state (MLSS) is useful to steer and monitor the training process of athletes. Unfortunately, the exact determination of MLSS needs several tests, which is not feasible for daily practice. A promising approach to accurately predict MLSS based on one single exercise test might be the use of the lactate minimum testing concept. Some years ago, the

so-called heart rate-based lactate minimum test (LMT-HR) developed at our institute (Strupler et al., 2009) revealed a high correlation between lactate minimum (LM) and MLSS (Perret et al., 2012). However, despite this high correlation, MLSS was systematically underestimated by LM. Thus, the aim of the present study was to modify the existing protocol in order to improve the results of the original LMT-HR protocol. Methods: 14 healthy non-smoking endurance-trained male athletes (age: 39.7y (SD: 8.2); height: 181cm (6); body mass: 79kg (7); VO<sub>2</sub>peak: 54ml/min/kg (5) randomly performed four different LMT-HR, i.e. the original test protocol plus three new test protocols. The new test protocols were modified by changing the starting workload, duration and/or the size of the workload increment during the second part of the LMT-HR. In addition, athletes performed several endurance tests in order to assess their individual MLSS. Heart rate (HR), workload, lactate concentrations and oxygen uptake at LM of the different test protocols were compared to corresponding MLSS data. Results: As expected LM of the original LMT-HR protocol significantly underestimated MLSS concerning HR (154bpm (8) vs. 165bpm (7), workload (208W (31) vs. 224W (19), blood lactate concentration (3.4mmol/l (1.2) vs. 4.6mmol/l (1.3) and oxygen uptake (39ml/min/kg (4) vs. 42ml/min/kg (3)), whereas two of three of the modified new LMT-HR protocols showed no statistically significant differences for all measured parameters comparing LM (HR: 162bpm (7) and 162bpm (8); workload: 228W (23) and 234W (30); lactate: 4.7mmol/l (1.7) and 5.3mmol/l (2.2); oxygen uptake: 41ml/min/kg (4) and 41ml/min/kg (4)) with MLSS data. Conclusions: It can be concluded that LM directly corresponds to MLSS in two of our modified new LMT-HR protocols; thus, these new protocols can be used in practice to accurately and easily predict MLSS based on one single exercise test. References: Perret C, Labruyère R, Mueller G, Strupler M. (2012). Correlation of heart rate at lactate minimum and maximal lactate steady state in wheelchair-racing athletes. *Spinal Cord* 50: 33-36. Strupler M, Mueller G, Perret C. (2009). Heart rate-based lactate minimum test - a reproducible method. *Br J Sports Med* 43: 432-436.

## PREDICTION OF ELITE TRIATHLON PERFORMANCE BY MULTIPLE LINEAR REGRESSION MODELS

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Introduction: The physical characteristics of triathletes were investigated in several studies, mostly with recreational athletes (Van Schuylenberg et al., 2004; Schabert et al., 2000). Only a few studies focused on the relationship between individual parameters and race performance (Schabert et al., 2000). Accordingly, the aim of the current study was to analyze whether Olympic distance triathlon performance of elite athletes might be predicted by multiple-linear regression models using specific parameters from performance diagnostics. Methods: The dataset combines anthropometric and physiological performance parameters of 25 laboratory tests of eleven male elite triathletes (20-32 years), collected at the IAT between 2008 and 2012. Initially, an exploratory factor analysis was used to preselect relevant parameters. Eleven anthropometric (e.g. body height, pelvis width and body fat) and twelve physiological parameters (e.g. blood lactate concentration (La), pace and respiratory rate during treadmill running (peak/per interval)) were considered. Two multiple linear regression analyses were used to determine appropriate parameters to predict overall race time [s] in Olympic distance, separated in one anthropometric and one physiological model ( $p < 0.05$ ). Results: Multiple linear regression model using anthropometric parameters explained 40 % ( $p < 0.01$ ) of the variance in overall race time. Pelvis width ( $\beta = -0.674$ ) and shoulder width ( $\beta = 0.434$ ) had a significant influence. Predicted race time could partially ( $R^2 = 0.405$ ,  $SEE = 155.14s$ ) be calculated by equation  $7643.56 - 80.889 \times (\text{pelvis width [cm]}) + 37.388 \times (\text{shoulder width [cm]})$ . Multiple linear regression model using physiological parameters explained 67 % ( $p < 0.01$ ) of the variance in overall race time. Running pace at 3-mmol/l La ( $\beta = -0.474$ ), maximum La ( $\beta = -0.450$ ) and maximum respiratory rate RR ( $\beta = 0.505$ ) had a significant influence. Predicted race time could partially ( $R^2 = 0.665$ ,  $SEE = 117.27s$ ) be calculated by equation  $8521.03 + 8.556 \times (\text{RR [breaths/min]}) - 332.80 \times (\text{running pace [m/s]}) - 61.658 \times (\text{max La [mmol/l]})$ . Discussion: The best predictors in the multiple linear regression model of overall race time in Olympic distance triathlon using anthropometric parameters were pelvis width and shoulder width. The multiple linear regression model based on physiological parameters included running pace at 3-mmol/l La, maximum La and maximum respiratory rate. In a next step a mixed model with anthropometric and physiological parameters as well as a non-linear approach will be calculated. Information about previous races (overall/split times) and training indicators could lead to a better prediction of the performance (Gilinsky, 2014). References: Gilinsky N et al. (2014). *J Sci Med Sport*, 17, 300-305. Schabert EJ et al. (2000). *Med Sci Sports Exerc*, 32 (4), 844-849. Van Schuylenbergh R et al. (2004). *Eur J Appl Physiol*, 91 (1), 94-99. Contact: marian.hoffmann@kit.edu

## VALIDATION OF MODIFIED D-MAX METHOD FOR CALCULATING INDIVIDUAL ANAEROBIC THRESHOLD IN WELL TRAINED MALE CYCLISTS

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Introduction To predict endurance performance and evaluate adaption to training in endurance athletes a laboratory test for retrieving the anaerobic lactate threshold is often used. The maximal rate of oxidative metabolism that can be sustained during prolonged exercise indicates preserved homeostasis and thereby sets the upper limit for long term endurance. Exercise intensities above the anaerobic threshold require an additional input from anaerobic energy sources resulting in blood lactate accumulation and reduced time to fatigue. The threshold is therefore a reliable and powerful predictor of performance in aerobic exercise lasting approximately 40-60 min. The work rate that elicits a blood lactate of 4 mmol/l (e.g. LT4) is widely used to determine the threshold, but by using a fixed lactate concentration, flexibility to account for inter- and intra-individual differences in aerobic and anaerobic metabolism is lost. Our hypothesis was that our modified D-max method (D-maxmod) would provide a more accurate performance related value by calculating the individual anaerobic threshold (IAT). Methods 20 males cyclists age  $36 \pm 5$  years, weight  $79.7 \pm 5.8$  kg, VO<sub>2</sub>max  $4.4 \pm 0.4$  l/min performed an incremental test on a cycle ergometer for calculation of LT (D-maxmod, and LT4) at two occasions separated by 8 weeks. The test consisted of 5 minutes long stages separated by 1 min of rest where lactate was sampled. The increase in work rate was 30 W/stage starting at 100 W and ended above LT4. Short after, an incremental test to fatigue (start at LT4 power, increase 20 W/min) was performed for assessment of VO<sub>2</sub>max, calculation of maximal aerobic power (MAP) and maximal power achieved in the test (Wmax). On a separate day a 40 minutes time-trial (TT40) was performed for assessment of aerobic endurance performance. IAT D-maxmod was defined as the derivate to the exponential curve created from exponentially lactate increase, including maximal lactate concentration plotted at MAP. The increase in lactate relative to power was defined as the increase in blood lactate from the point where the exponential curve crossed the lactate baseline (See also Cheng et al. 1992 and Zhou & Weston 1997). Results IAT D-maxmod was calculated to  $5.0 \pm 0.8$  mmol/l. Both D-maxmod and LT4 were highly significantly correlated with both TT40 and Wmax. Coefficients of determination were higher for D-maxmod compared to LT4 for both TT40 ( $r^2 = 0.78$  vs  $0.69$ ) and Wmax ( $r^2 = 0.89$  vs  $0.64$ ). Conclusion The calculated D-maxmod correlated better with performance than LT4 for parameters highly linked to performance in road- and mountain bike competitions. References Cheng B, Kuipers H, Snyder AC, et al. (1992). *Int. J Sports Med*. 13:518-22 Zhou S, Weston SB (1997). *Physiol. Meas.* 18: 145

### CONVENTIONAL CRITICAL POWER TEST PREDICTS 16.1 KM ROAD TIME TRIAL PERFORMANCE

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**Introduction** Critical power (CP) and 'functional threshold power' (FTP) are indices of aerobic fitness and strong predictors of endurance performance (Smith et al., 1999). Completion time (T<sub>lim</sub>) during a cycling time trial (TT) can be predicted on the basis of the CP (asymptote) and W' (curvature constant) parameters of the power-duration relationship according to the equation  $T_{lim} = (W - W')/CP$ , where W indicates total work done during the TT. However, the accuracy of this performance prediction when CP and W' are estimated by on-bike power meters is unclear. The FTP test is a popular fitness test for cyclists but its agreement with CP is also yet to be determined (Gavin et al. 2012). Therefore, the aims of this study were to test the hypotheses that: 1) 16.1 km TT performance on the road would be accurately predicted from laboratory-based estimates of CP and W' using on-bike power meters; and 2) FTP would be significantly correlated with CP. **Methods** Following ethical approval, 13 competitive male cyclists (VO<sub>2</sub> peak of  $63.48 \pm 6.54$  ml•kg<sup>-1</sup>•min<sup>-1</sup>) completed 4-5 TT exercise bouts for the estimation of CP and W', and a 20 min TT (FTP test). These trials were completed in the laboratory with the participant's individual competition bike loaded onto a static trainer for rear wheel power output measurement (PowerTap, CycleOps). Subjects also performed a 16.1 km TT on the road on one occasion with the same power measuring device. 16.1 km TT performance was predicted using the equation  $T_{lim} = (W - W')/CP$ . Results CP and W' derived from the power-time relationship were estimated at  $277 \pm 42$  W and  $19.5$  kJ  $\pm$  6.5 kJ, respectively, while FTP was  $278 \pm 42$  W. FTP and CP were not significantly different ( $P > 0.05$ ) and these variables were significantly correlated ( $r = 0.96$ ,  $P < 0.05$ ). Predicted 16.1 km TT performance ( $27.32 \pm 3.29$  min) was within 4.4% of, and not significantly different to, actual TT performance ( $26.66 \pm 2.17$  min,  $P > 0.05$ ). **Discussion** Our findings suggest that CP and W', as derived from mobile power meters in the laboratory, may be used to accurately predict 16.1 km cycling TT performance on the road. In addition, we observed a close agreement between FTP and CP, suggesting that the FTP may provide a time efficient, single-test estimate of the CP. These observations may help inform, and improve the accessibility of, testing procedures that can be employed to predict TT performance in competitive cyclists. **References** Gavin, T.P., Van Meter, J.B., Brophy, P.M., Dubis, G.S., Potts, K.N., and Hickner, R.C. (2012). J Strength Cond Res, 26(2):416-21. Smith, J. C., Dangelmaier, B. S., and Hill, D. W. (1999). Int J Sports Med, 20(6), 374-378. Contact pm273@exeter.ac.uk

### RELATIONSHIP OF PHYSIOLOGICAL FACTOR CHANGES IN JAPANESE UNIVERSITY DISTANCE RUNNERS

Tanji, F., Shirai, Y., Enomoto, Y., Nabekura, Y.

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**Introduction** Maximal oxygen uptake (VO<sub>2</sub>max) and running economy (RE) are important factors for long distance runners. The presence of good indicators results in great running performance. A positive relationship between VO<sub>2</sub>max and RE has been reported (Fletcher et al. 2009). However, it is unclear how the change in one indicator affects the change in the other indicator in each runner. Japanese athletes have two race seasons. These generally take place between April and June and between September and November, with the periods from December to March and from July to August acting as preparation seasons. The main training in the competitive phase is tapered for the race, which differs from preparation phase training. Physiological factors might change according to the phase. Therefore, the aim of the present study was to measure VO<sub>2</sub>max and RE three times throughout year to clarify the relationship of physiological factor changes. **Method** Sixteen male university long-distance runners who completed the same training were studied. Measurements of VO<sub>2</sub>max and RE were taken in July, December and the following March. Participants ran in a multi-stage incremental load test for 3 min at 230, 250, 270, 290 and 310 m/min. RE was evaluated as the running cost (kcal/kg/km) using the method described by Kyröläinen et al. (2001). vVO<sub>2</sub>max was evaluated as a performance factor. **Result** A positive significant relationship was observed changes in the VO<sub>2</sub>max value and changes in the RE value above LT intensity running among runners ( $P < 0.05$ ). Many improving performance runners were plotted under the VO<sub>2</sub>max-RE regression line area. In addition, in each runner, a positive significant relationship was observed between VO<sub>2</sub>max and RE. VO<sub>2</sub>max tended to increase from July to December ( $P = 0.11$ ), but it did not change significantly throughout the year ( $70.5 \pm 5.7$ ,  $73.3 \pm 5.9$  and  $70.6 \pm 5.9$  ml/kg/min). Further, RE at all velocity and vVO<sub>2</sub>max did not change significantly throughout the year. **Discussion** Results of the present study indicated that RE decreased when VO<sub>2</sub>max increased by training. Improvement in either factor limited the reduction in the other factor because a positive relationship between VO<sub>2</sub>max and RE in each runner. Therefore, the balance between high VO<sub>2</sub>max and RE was important. On the other hand, relationships between these factors and performance changes were not observed by season. Further investigation is needed to determine how training lead to the change in the factors. **Reference** Fletcher JR, Esau SP, MacIntosh BR. (2009) Economy of running: beyond the measurement of oxygen uptake. J Appl Physiol 107: 1918-1922 Kyröläinen H, Belli A, Komi PV. (2001) Biomechanical factors affecting running economy. Med Sci Sports Exerc 33: 1330-1337 Contact fumiya.tanji.238@gmail.com

## Oral presentations

### OP-PM70 Molecular Biology and Biochemistry: Epigenetics

#### APOE GENE VARIANTS AND CONCUSSION SEVERITY

September, A.V., Abrahams, S., Mc Fie, S., Patricios, J., Suter, J., Posthumus, M.

*University of Cape Town*

**Introduction:** Concussion is the transmission of biomechanical forces to the head resulting in neurological deficits, stimulating elevated release of brain tissue damage markers and promoting neural cell death. Apolipoprotein E is involved in nerve tissue integrity and encoded by the APOE gene. The ε4 allelic variant of the APOE gene was associated with greater severity for brain injury in boxers. Therefore, this study's aim was to investigate the association between APOE variants and concussion profile in rugby players. **Materials and Methods:** In this case-control genetic association study, 198 previously concussed cases and 129 non-concussed, sport-matched controls (age: 15 – 39 years old) were recruited from rugby playing schools and clubs. Participants were genotyped for rs405509 (G/T), rs429358 (ε3/ε4) and rs7412 (ε2/ε3) variants within the APOE gene. Sport, concussion and medical history were recorded. Inferred haplotype analyses were conducted. **Results:** No significant genotype or allele frequency differences were noted between cases and controls ( $>P = 0.149$ ) and for concussion symptom duration in cases ( $>P = 0.253$ ). However, the frequencies of the age-adjusted inferred G-ε4-ε3 (28% vs. 24%;

$P < 0.001$ ) and G- $\epsilon$ 3- $\epsilon$ 2 (25% vs. 19%;  $P = 0.001$ ) haplotypes, of the APOE variants (rs405509-rs429358-rs7412), were significantly greater among cases compared to controls respectively. Conclusion: Although the independent APOE genotype frequencies were not associated with concussion susceptibility or severity, the combined effect of the three APOE variants implicates APOE in concussion susceptibility. Further exploration is needed to understand the complex role of APOE in susceptibility.

### GENDER DIFFERENCES IN MAXIMAL MITOCHONDRIAL RESPIRATORY CAPACITY IN ADIPOSE TISSUE BUT NOT IN MUSCLE AFTER INTENSIVE LIFESTYLE INTERVENTION

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Introduction Weight loss and increased maximal oxygen uptake (VO<sub>2</sub>max) is the purpose of most intensive lifestyle interventions (ILI). Maximal mitochondrial respiratory capacity (MMRC) in skeletal muscle (SM) increases with aerobic training (AT) in both women (W) and men (M), but it is uncertain how a concomitant WL will influence the adaptation to ILI. In addition W have more subcutaneous adipose tissue (SAT) than M (1), but whether there are gender differences in the MMRC of the SAT is unclear. We hypothesized that MMRC would increase more in SM than in SAT after an ILI and that W would have a higher MMRC in the SAT than M. Methods 41 obese W and 21 obese M (BMI: 36.9  $\pm$  0.2, 39.0  $\pm$  0.2; Fat %: 44.9  $\pm$  1.3, 38.2  $\pm$  0.9) attended 11 weeks of ILI consisting of AT (1-3 hours/day) and hypo-caloric healthy diet (~ -500 Kcal/day). Biopsies from m. vastus lateralis and the abdominal SAT were obtained before and after the ILI. MMRC was determined using high-resolution respirometry (Oxygraph-2k, Austria). VO<sub>2</sub>max was measured on a graded cycle test (Cosmed Quark CPET, Italy) and body composition was measured by bio-impedance (Quantum X, USA). Results W and M lost body weight (W: 102  $\pm$  4 to 93  $\pm$  3; M: 126  $\pm$  5 to 114  $\pm$  4 kg,  $p < 0.001$ ) and increased VO<sub>2</sub>max (W: 2554  $\pm$  85 to 2701  $\pm$  86; M: 3113  $\pm$  100 to 3629  $\pm$  119 ml O<sub>2</sub>/min,  $p < 0.01$ ) after the ILI, respectively. M were heavier and had a higher VO<sub>2</sub>max than W ( $p < 0.001$ ), but W had a higher whole body fat % ( $p < 0.001$ ). Coupled and uncoupled MMRC increased in SM after the ILI in both W and M, respectively, (W: 53  $\pm$  3 to 62  $\pm$  2, 66  $\pm$  3 to 74  $\pm$  2; M: 52  $\pm$  2 to 64  $\pm$  2, 67  $\pm$  3 to 76  $\pm$  3 pmol/mg/s,  $p < 0.001$ ) but no effect of the ILI was found in the SAT (W: 1.1  $\pm$  0.1 to 1.1  $\pm$  0.1, 1.3  $\pm$  0.1 to 1.3  $\pm$  0.1 kg, M: 1.0  $\pm$  0.1 to 1.0  $\pm$  0.1, 1.2  $\pm$  0.1 to 1.2  $\pm$  0.1 pmol/mg/s). However, there was a trend towards higher coupled and uncoupled MMRC in SAT in W than in M ( $p = 0.09$ ,  $p = 0.06$ ). Discussion The main finding was that the MMRC increased after the ILI for both genders in SM, but not in SAT. Furthermore, in SAT there was a trend towards a gender difference, which was unrelated to the ILI. The findings imply that the ILI affects the metabolism in SM but not in SAT, and that W may have a higher metabolic rate in SAT than M. In line with that W also have a higher lipolytic sensitivity in abdominal SAT than M (1). Thus, the molecular differences related to MMRC and lipolytic sensitivity of SAT in W and M, respectively, may contribute to elucidation of why W are less prone to develop ectopic fat storage in non-adipose tissues than M. References 1) Williams C, Proc. Nutr. Soc. 2004, 63. Contact: sunedj@sund.ku.dk

### THE INDIVIDUAL AND COMBINED ASSOCIATION BETWEEN MULTIPLE GENE POLYMORPHISMS AND ELITE ENDURANCE ATHLETE STATUS

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A complex phenotype is required for endurance performance. Therefore, it is likely that 'elite status' is polygenic. We investigated individually, and in combination, eight gene polymorphisms (ACE rs1799752, ACTN3 rs1815739, AGT rs699, HIF1A rs11549465, PPARGC1A rs8192678, UCP2 rs659336, UCP2 rs660339 and UCP3 rs1800849) and elite endurance athlete status in male and female marathon runners. Marathon runners (272 Caucasians) were stratified by personal best (PB) into elite (men <2 h 30 min, women <3 h) and sub-elite (men <2 h 45 min, women <3 h 15 min) and compared to 528 Caucasian controls. There were initially some differences in AGT and PPARGC1A genotype and allele frequency between the stratified groups. However, after correction for multiple testing using the Holm-Bonferroni method, no significant differences in genotype or allele frequency remained between those groups. When considering PB, in women the PPARGC1A CC genotypes ran the marathon approximately 5 min 38 s faster than other genotypes ( $P = 0.046$ ), which is generally consistent with previous literature. The combined impact of all eight polymorphisms was assessed, with athletes classified according to the number of endurance alleles they possessed and a Total Genotype Score (TGS) generated. There was no significant correlation between TGS and PB ( $P = 0.871$ ), nor any differences between the TGS of athletes and controls as a combined cohort or when stratified by sex ( $P \geq 0.365$ ). An unexpected finding was that male elite athletes had a TGS approximately 8% lower than controls (36.5 vs 39.3,  $P = 0.042$ ). In summary, these results suggest that PPARGC1A should be considered a favourable genetic marker in elite marathon running and emphasises the role of this gene and its expression in oxidative metabolism. However, a lack of association between marathon PB and any other individual polymorphism studied, combined with the TGS unexpectedly being lower in elite athletes despite the variants and endurance alleles being selected from previous literature, demonstrates the need to apply hypothesis-free approaches in large cohorts of well-defined athlete groups if substantial genotype-phenotype associations are to be identified successfully.

### ENDURANCE TRAINING-STIMULATED FNDC5/IRISIN INDUCES BEIGE ADIPOSE-LIKE PHENOTYPE IN VISCERAL ADIPOSE TISSUE OF OBESE RATS

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Introduction Exercise stimulates muscle-derived cytokines production that have pleiotropic effects in multiple tissues, including adipose tissue. The recently discovered FNDC5/irisin, an exercise-induced PGC-1 $\alpha$ -dependent myokine, is secreted into circulation and has the ability to brown adipose tissue, which is associated with greater whole-body energy expenditure and protects against obesity-related metabolic disorders. Therefore, we aimed to analyze whether voluntary physical activity and endurance training induces beige adipose-like phenotype in visceral adipose tissue from obese rats. Methods Male rats were assigned into sedentary (S), voluntary physical activity (VPA) and endurance training (ET) groups fed with two isocaloric diets, standard (STD) and HFD (35% or 70% fat-derived Kcal, respectively) as follows: S35, VPA35, ET35, S70, VPA70 and ET70 during 17 wks. VPA-animals had free access to running wheel throughout the entire protocol. After 9-wk of HFD, ET-animals performed 8-wks of endurance training on treadmill while maintained dietary treatments. Fibronectin type III domain-containing protein 5 (FNDC5) was determined in gastrocnemius muscle, uncoupling protein (UCP1), adiponectin and leptin in epididymal adipose tissue (EPI), peroxisome proliferator-activated receptor- $\gamma$ coactivator (PGC-1 $\alpha$ ) in both tissues by Western Blot. Results HFD significantly increased body weight (BW) and visceral adiposity index (VAI). In muscle tissue, HFD augmented PGC-1 $\alpha$  (S70 vs. S35) although no alterations were observed in FNDC5 protein levels. In EPI fat depot, UCP1 and PGC-1 $\alpha$  protein levels were reduced in

HFD-fed animals but adiponectin and leptin protein levels were unchanged. VPA decreased BW and VAI compared to sedentary counterparts (VPA35 vs.S35; VPA70 vs.S70). EPI adiponectin, leptin, PGC-1 $\alpha$ , UCP1 and muscle FNDC5 levels remained unchanged in VPA animals. ET significantly decreased BW, VAI and EPI leptin levels in both diets however had no effect on adiponectin. A pronounced ET effect was observed by increases in heart/body weight ratio and muscle citrate synthase. ET increased muscle FNDC5 protein levels accompanied by an increase in EPI UCP1 and PGC-1 $\alpha$  in both diets compared to sedentary counterparts. A significant positive correlation between leptin and VAI and a negative correlation between leptin and FNDC5 and UCP1 were found. Discussion Our results suggest that ET-related increases in skeletal muscle FNDC5 protein levels contributed, at least in part, to induce beige adipose-like phenotype in visceral adipose tissue of obese rats. Contact silviadarocharodrigues@gmail.com

## Oral presentations

### OP-PM42 Training & Testing: Strength III

#### ASSESSMENT OF ISOKINETIC KNEE STRENGTH AND ITS RELATIONSHIP WITH VERTICAL JUMP AND POWER IN YOUTH BASKETBALL PLAYERS

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**Introduction** The purpose of the study was to measure the isokinetic concentric strength of the knee muscle groups, and their relationship with the vertical jump performance in youth male basketball players. **Methods** Thirty six youth male basketball players (age =15  $\pm$  1.5 years) performed a countermovement jump, and an isokinetic knee test using the Humac Norm dynamometer. The maximal isokinetic peak torque of the knee extensor and flexor muscles was recorded at two angular velocities (60°s<sup>-1</sup>, 300°s<sup>-1</sup>) for both the dominant and non-dominant legs. **Results** There was no significant difference between dominant and non-dominant leg at both angular velocities (both  $p > 0.05$ ). Moderate significant positive correlations (all  $p < 0.05$ ) were detected between the isokinetic measures of the knee extensors and flexors and the vertical jump height for both angular velocities with the strongest ones measured at 60°s<sup>-1</sup>. Furthermore, when power calculated from vertical jump used to determine the relationship with the two angular velocities the results demonstrated strong significant positive correlations (all  $p < 0.0001$ ). The hamstrings to quadriceps (H/Q) ratio at 60° s<sup>-1</sup> for both right and left knee had no significant correlation with vertical jump performance again with the strongest ones measured at 60°s<sup>-1</sup>. **Conclusion** The results demonstrated that moderate relationship could be obtained between isokinetic knee extensors and flexors strength and vertical jump height. Interestingly, the stronger relationships occurred when vertical jump was used to calculate the power in youth male basketball players. Caution should be taken when using vertical jump alone to determine the optimal isokinetic speed in this group of sportsmen.

#### VALIDATION OF ISOMETRIC STRENGTH-TESTING DEVICES FOR DIFFERENT ANKLE MOVEMENTS

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**Introduction** Ankle joint is one of the main joints of lower limb with the purpose to support and move the body (Sarrafian, 2011). Most important ankle movements are plantar flexion, dorsiflexion, ankle eversion and inversion. Knowledge of the muscle strength which implements above-mentioned ankle movements is important for athletes, seniors and everyone who is in a process of ankle rehabilitation. For this purpose we had developed two strength testing devices for measuring isometric contraction in vertical and in horizontal direction. The aim of this research was to determine whether the results of the isometric devices are accurate and repeatable. **Methods** The research included 14 students (20,3  $\pm$  0.4 years, 171.5  $\pm$  5,2 cm, 70,6  $\pm$  9.2 kg). Participants were performing four different isometric contractions in the ankle joint: plantar flexion (PF), dorsiflexion (DF), ankle eversion and inversion, all in seated position. PF and DF were performed in isometric strength-testing device, which measured torque in vertical direction, while ankle eversion and inversion were measured with a device which measured torque in a horizontal direction. Plantar surface of the foot was horizontally placed on the ground. Within the 4 weeks period participants performed multiple measurements, and we tracked the development of the torque. In the analysis, we observed results between the four measuring days for all ankle tasks and between two repetitions that were performed on the same day for one ankle task. To identify the differences between two repetitions for single task in one day and to identify the differences between four measuring days for four tasks we used the intraclass correlation coefficient – ICC (Field, 2009). **Results** The results showed very high correlation of ICC ( $r > 0.9$ ) for first and second repetition for each task. Comparisons among the best repetition for each measuring day showed a very high correlation in inversion ( $r = 0,913$ ) and DF ( $r = 0,966$ ), high correlation in PF ( $r = 0,706$ ) but average correlation in eversion ( $r = 0,680$ ). Value of ICC, when compared first and fourth repetition at ankle eversion, was extremely low ( $r = 0,198$ ). **Discussion** Among four measuring days is a very high correlation in inversion, DF and high in PF. This means that these two strength-testing devices measure reliably and that the results of the measurements are repeatable. We notice medium correlation between all four repetitions of measuring day in ankle eversion, but no correlation between first and fourth day of measurement. Therefore we can conclude that when measuring ankle eversion learning process has a large impact on this measurement. **References** Sarrafian S., Kelikian, A., S. (2011). Sarrafian's Anatomy of the Foot and Ankle: Descriptive, Topographic, Functional, Third Edition. Lippencott Williams & Wilkins. Field, A. P. (2009). Discovering statistics using SPSS. London, England : SAGE.

#### SEX DIFFERENCES IN MEASURES OF POWER AND VELOCITY DURING DEADLIFTING

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**Introduction** Men have more muscle mass than women, which results in greater force and power when comparing Olympic lift and squat performance at the same relative intensity. However, whether these differences exist when normalized to fat free mass (FFM) is unknown. This study sought to determine if sex differences existed in power and barbell velocity at various loads in the conventional deadlift (CDL) when normalized to FFM. **Methods** Women (n=9, mean  $\pm$  SEM: 29  $\pm$  2yrs, 162.3  $\pm$  1.8cm, 62  $\pm$  2.4kg) and men (n=9, 29  $\pm$  3yrs, 175.6  $\pm$  1.8cm, 85.5  $\pm$  1.4kg) with  $\geq 1$  year of CDL experience participated in four testing sessions. Session 1 consisted of body composition assessment ([BodyPod] women: 23.3  $\pm$  3.2% body fat (BF), men: 14.8  $\pm$  2.4%BF) and a maximal (1RM) CDL test. In sessions 2-4,

which were separated by 7 days each, subjects completed a supervised warm-up followed by three CDL repetitions separated by 2-min rest at each of three randomly assigned workloads (30%, 60%, 90% of 1RM). Average velocity (AV), peak velocity (PV), average power (AP), and peak power (PP) were measured by the Tendo® Analyzer (Tendo Sport Machines, Slovak Republic), which was attached inside the sleeve of the barbell. A 2 x 3 repeated measures ANOVA was used to analyze AV, PV, AP, and PP ( $\alpha$ :  $p < 0.05$ ). Results Men had a greater CDL 1RM ( $197 \pm 16$  vs.  $100 \pm 6$  kg;  $p < 0.001$ ), which contributed to greater overall AP when collapsed across loads ( $698 \pm 36$  vs.  $336 \pm 36$  W;  $p = 0.001$ ). AP and PP were greatest at 60% in all subjects, with men producing greater PP at all loads ( $p < 0.001$ ). AV was higher for men at 30% ( $p < 0.001$ ), while PV was higher at 30% and 60% ( $p < 0.05$ ). All subjects generated the greatest AV and PV at 30% ( $p < 0.001$ ). When normalized to FFM, similar observations were made in both AP and PP with men being greater. However, post hoc analysis on the sex effect showed that, when collapsed across loads, women produced higher AV ( $0.014 \pm 0.001$  m•s<sup>-1</sup> • kg FFM<sup>-1</sup>) and PV ( $0.021 \pm 0.001$  m•s<sup>-1</sup> • kg FFM<sup>-1</sup>) than men (AV:  $0.010 \pm 0.001$  m•s<sup>-1</sup> • kg FFM<sup>-1</sup>; PV:  $0.015 \pm 0.001$  m•s<sup>-1</sup> • kg FFM<sup>-1</sup>) ( $p < 0.05$ ). Discussion A paucity of research exists in regard to sex differences in power and velocity during the CDL. Current results are in agreement with previous findings that showed men produce greater power across a range of loads. However, this study demonstrates that at higher intensities (60% and 90%), greater power is driven solely by force production, as AV did not differ at 60% or 90% of 1RM. Further, when normalized to FFM, women produce significantly higher velocities. In conclusion, the CDL may be used to improve power in women. References Garhammer, J (1991). *Int J Sport Bio* 7, 3-11. Pallares et al. (2012). *J Strength Cond Res* 26(3), 794–803. Thomas et al. (2007). *J Strength Cond Res* 21(2), 336–342.

## HEAVY STRENGTH TRAINING DOES NOT AFFECT PERFORMANCE IN JUNIOR FEMALE CROSS-COUNTRY SKIERS

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Introduction Performance in cross-country (XC) skiing is highly related to the maximal aerobic power. However, during sprint- and mass start events the ability to perform supra-maximal workloads is important and maximal strength training has therefore gained interest as a training model. Gender differences in performance increases with increasing involvement of the upper body (Sandbakk et al., 2014). Hence, improved upper-body strength can potentially improve double poling (DP) performance in female XC skiers. Methods Sixteen well-trained females skiers ( $17 \pm 1$  yrs,  $60 \pm 6$  kg,  $169 \pm 6$  cm, maximal oxygen uptake running:  $60 \pm 5$  mL • kg<sup>-1</sup> • min<sup>-1</sup>) were assigned either to an intervention group (INT;  $n=9$ ) or a control group (CON;  $n=7$ ). INT completed two weekly sessions of upper-body heavy strength training for 10 weeks in addition to their normal endurance training, while CON continued their normal endurance training. The skiers were tested for 1 repetition maximum (1RM) in seated pull-down exercise, submaximal and maximal O<sub>2</sub>-uptake and two performances test in a DP ergometer (3-min all out in rested- and fatigued state). Results Body weight increased significantly in both INT (mean  $\pm$  90% CI) ( $2.5 \pm 1.2\%$ ;  $p < 0.01$ ) and in CON ( $2.6 \pm 1.9\%$ ;  $p < 0.05$ ). 1RM increased significantly more in INT ( $24 \pm 5\%$ ;  $p < 0.01$ ) than in CON ( $8 \pm 7\%$ ;  $p < 0.05$ ), with a group difference of  $15 \pm 8\%$  ( $p < 0.01$ ; ES: 0.90). No significant changes were seen in sub-maximal O<sub>2</sub>-cost from pre- to post-test in either INT or CON. VO<sub>2</sub>max relative to body mass decline significantly in INT ( $-3.7 \pm 2.2$ ;  $p < 0.05$ ) and was unchanged in CON ( $0.0 \pm 2.8\%$ ). DP performance in rested- and fatigued state increased in both groups ( $\sim 16\%$ , all  $p < 0.05$ ) with no group differences in either pre-values, post-values or change score (ES: 0.04-0.07). Discussion Adding heavy strength training to high volume endurance training increased muscle strength but had no effect on performance in DP. Sub-maximal O<sub>2</sub>-cost did not change after adding strength training, a finding that is in agreement with recent studies in XC skiing (Losnegard et al., 2011; Rønnestad et al., 2012). These results together with previous studies indicate that heavy strength has trivial impact on performance in young XC-skiers and that endurance- and technique training should be prioritized. References Losnegard et al. (2011). *Scand J Med Sci Sports*: 21: 389-401. Rønnestad et al. (2012). *Eur J Appl Physiol*: 112: 2341-2352. Sandbakk et al. (2014) *Scand J Med Sci Sports*: 24: 28-33. Contact Thomas.losnegard@nih.no

## STRETCH INDUCED MUSCLE HYPERTROPHY IN THE HUMAN TRICEPS SURAE OF YOUNG MALES

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Introduction Muscle hypertrophy attributable to chronic stretching was previously shown in animal studies (Holly et al., 1980, Sola et al., 1973), however there is little evidence of this in humans. The purpose of this study was to examine whether 6-weeks of chronic stretch training induces adaptations in force and muscle architecture of the gastrocnemius Achilles tendon unit indicative of muscle hypertrophy. Methods Five days/week for 6-weeks the non-dominant ankle of 11 males (age  $22 \pm 3$  years) was rotated to maximal dorsiflexion and passively stretched against a load (20–60% MVC) for 3 minutes. Muscle strength, body composition (Hologic Discovery DXA), muscle fibre length, pennation angle, muscle cross-section and tendon length (B1500 E9 GE Ultrasound) of the triceps surae and Achilles tendon of both legs were measured at zero, three, six and one week after the conclusion of stretch training at week seven. Data were compared to the contralateral leg, and 10 non-exercised controls (age= $21 \pm 2$  years). Results Muscle cross-section area at 3 (11%) and 6 weeks (8%) was significantly larger from week zero ( $p < 0.05$ ). Muscle fibres at the junction of the gastrocnemius medialis and Achilles tendon were longer at 3 (25% increase), 6 (21% increase) and 7 weeks (19% increase) compared to week zero ( $p < 0.05$ ). Total body composition did not change, but force decreased at 3 (6.58%), 6 (7.80%) and 7 weeks (7.12%) compared to zero ( $p < 0.05$ ). All changes were significant from the contralateral leg, and control group ( $p < 0.05$ ). Discussion Six weeks of loaded chronic stretch training increased gastrocnemius cross-section and lengthened the fibres at the muscle tendon junction. Static stretching stimulated an increase in size and length of muscle fibres, but body composition did not change, and force decreased suggesting that hypertrophic adaptations to stretch lessen force production. References Holly, R.G., Barnett, J.G., Ashmore, C.R., Taylor, R.G., Mole, P.A. (1980). Stretch-induced growth in chicken wing muscles: a new model of stretch hypertrophy. *Am J of Physiol Soc*. 238(1):C62-C71 Sola, O.M., Christensen, D.L., Martin, A.W. (1973). Hypertrophy and hyperplasia of adult chicken anterior latissimus dorsi muscles following stretch with and without denervation. *Exp Neurol*. 41(1):76-100 simpson\_cl@hotmail.com

## CONTRIBUTION OF LEG MUSCLE FORCES TO PADDLE STROKE FORCE AND KAYAK SPEED DURING MAXIMAL EFFORT FLAT-WATER PADDLING AMONG ELITE KAYAKERS

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Introduction: In flat-water sprint kayaking the paddling technique among elite kayakers has changed and is presently characterized by a more prominent use of the trunk and leg muscles than before (Michael et al 2009). The importance of trunk rotation with leg movements

has support in notational analysis research (Brown et al 2011) but the contribution of leg muscle forces to paddle force and kayak speed has not been carefully investigated. Begon and co-workers (2010) has used a kinematic simulation to analyze the contribution of the lower limbs to ergometer kayaking performance but the leg produced forces during ecological conditions in flat-water sprint kayaking has not yet been investigated. Methods: Five male elite kayakers performed, after a warm up, a sequence of perceived-maximal-speed paddling starting from zero and to remain at maximal speed for about 10 s. This was done with normal leg work and after a short rest with restricted leg work i.e. when the knee joints were kept in a locked position. The leg forces were recorded on the foot-bar with a new and recently described device (Nilsson and Rosdahl 2014) while the paddle stroke forces were recorded by moveable strain-gauge-based sensors. These data was stored together with data from a GPS and an electrogoniometer in a portable custom-built data-acquisition system placed in the kayak. Results and Discussion: The mean paddle stroke force was reduced by 21% and kayak speed by 16% with restricted leg action which highlights the importance of the leg muscle generated forces. A greater contribution from leg muscle contractions and larger paddle force, results in a higher speed and shorter water thrust phase duration, which in turn will increase the paddle cycle rate. The large gain in speed with normal leg action indicates the possibility to emphasize the leg action among kayakers to optimize performance. Accordingly, future research and training may focus on which is the best way to synchronize the leg action phase with respect to the paddle water phase and to perform these phases to best transfer forces from leg muscles to the propulsion of the kayak. References Brown MB, Lauder M and Dyson R. Notational analysis of sprint kayaking: Differentiating between ability levels. *Int J Perform Analysis in Sport*, 2011;11: 171-183. Begon M, Colloud F and Sardain P. Lower limb contribution in kayak performance: modeling, simulation and analysis. *Multibody Syst Dyn*.2010;23:387-400. Michael JS, Smith R, Rooney KB. Determinants of kayak paddling performance. *Sports Biomech*. 2009;8:167-179. Nilsson J and Rosdahl H. New devices for measuring forces on the kayak foot-bar and on the seat during flat-water kayak paddling. *Int J Sports Physiol Perform*. 2014; 9 (2): 365-370.

## Oral presentations

### OP-PM23 Physiology: Energy metabolism

#### GREATER FAT UTILISATION DURING ECCENTRIC CYCLING THAN CONCENTRIC CYCLING

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Purpose It has been previously shown that fat utilisation is greater during and after eccentric cycling when compared with concentric cycling at the same power output [1]. However, it is unknown if differences in fat oxidation occur when exercising at the same oxygen consumption, and whether this relationship may change with exercise intensity. As such, this study compared substrate oxidation, energy expenditure, power output, mechanical work, efficiency, and heart rate between eccentric and concentric cycling matched for oxygen consumption and perceived exertion (RPE; 6-20 scale). Methods Sixteen recreationally active men ( $24 \pm 2$  y) performed a bout of 30 min concentric and a bout of 30 min eccentric cycling one week apart. Each bout consisted of 15 min of cycling at 50% VO<sub>2</sub>max and 15 min of cycling at various RPEs; (i.e. 8, 13, 16), with a 10-min passive rest between the two. Fat and carbohydrate oxidation, energy expenditure, relative VO<sub>2</sub>, relative power output, mechanical work and efficiency, relative heart rate and respiratory exchange ratio were assessed during each cycling bout. Results Fat oxidation was greater during eccentric compared with concentric cycling at 50% VO<sub>2</sub>max ( $p=.002$ ) and at an RPE of 13 ( $p=.008$ ) and 16 ( $p<.001$ ). Conversely, carbohydrate oxidation was greater during concentric compared with eccentric cycling at 50% VO<sub>2</sub>max and at an RPE of 13 and 16 (all  $p<.001$ ). Total energy expenditure was greater during concentric compared with eccentric cycling at 50% VO<sub>2</sub>max and at an RPE of 13 and 16 (all  $p<.001$ ). VO<sub>2</sub> was greater during concentric compared with eccentric cycling at an RPE of 8, 13 and 16 (all  $p<.001$ ). Power output was greater during eccentric compared with concentric cycling at 50% VO<sub>2</sub>max during the first, second and third 5 min as well as at the same perceived exertion as concentric cycling (both  $p<.001$ ). Efficiency was greater during eccentric compared with concentric cycling at 50% VO<sub>2</sub>max and at all RPEs (both  $p<.001$ ). Heart rate was greater during eccentric cycling at 50% VO<sub>2</sub>max ( $p=.002$ ) but greater during concentric cycling at RPE of 13 and 16 (both  $p<.001$ ). Discussion and Conclusion This study indicates that fat oxidation is greater during eccentric compared with concentric cycling at the same oxygen consumption and the same RPE, and fat oxidation increases with increasing intensity during eccentric cycling. Reference 1) Peñailillo et al. *Eur J Appl Phys*. (2014) 114:804-814.

#### ULTRA ENDURANCE EXERCISE AND CHANGES IN LEAN MASS

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Introduction In ultra endurance events the ability to maintain body mass is often compromised due to a restricted energy intake and high energy expenditure. The following case report details the body composition changes of 6 athletes competing in 4 different ultra endurance events. Methods The athletes observed took part in 4 different ultra endurance events. Three male athletes ( $39.4 \pm 7.1$  years) participated in the 2014 Marathon des Sables (running 251 km in 6 days); one female athlete (38.1 years) participated in the 2014 solo Race Across America (cycling 2,150km and withdrew after 9 days due to injury); one male athlete (36.4 years) skied from the coast of Antarctica to the South Pole (1,150 km in 29.8 days); and one male athlete (36.1 years) skied from the Antarctic coast to the South Pole and back (2,888 km in 105 days). Each athlete received comprehensive, structured nutrition and physiology support. Body composition was measured as close as possible pre and post each event (11.6 $\pm$ 12.1 and 8.1 $\pm$ 5.7 days, respectively) using dual energy x-ray absorptiometry. Results No significant difference was detected in total body mass (BM) between pre and post event (84.43 $\pm$ 10.72 vs. 81.93 $\pm$ 10.44 kg) across all challenges, however in the events lasting >10 days (>10 d) a mean BM loss of 5.65 $\pm$ 1.91 kg was observed compared to 0.93 $\pm$ 0.88 kg in <10 days (<10 d) events. Total lean mass (LM) increased significantly post event (64.07 $\pm$ 11.58 to 65.00 $\pm$ 11.99 kg); the trunk region exhibited the greatest increase (29.43 $\pm$ 4.83 to 30.93 $\pm$ 5.45 kg). In events lasting >10 d trunk LM increased by 2.68 $\pm$ 0.73 kg compared to 0.92 $\pm$ 0.73 kg in events lasting <10 d. Limb LM demonstrated a greater decrease in >10 d events (-1.69 $\pm$ 0.28 vs. -0.02 $\pm$ 0.58 kg). In the weight bearing challenges, bone mineral density (BMD) significantly decreased (1.393 $\pm$ 0.17 to 1.380 $\pm$ 0.169 mg/cm<sup>2</sup>); no changes were observed in the cyclist. Discussion The data presented demonstrate that multi-day exercise can result in increases in lean mass, the trunk exhibiting the greatest increase. In the two >10 d events the athletes were pulling a sled (>60 kg weight) resulting in a heavy isometric load on the trunk and a repetitive low resistance load on the limbs. This unique combination of exercise potentially led to the observed increases in trunk LM and decreases in limb LM. Similar but lower magnitude body composition changes were observed in <10 d events,

highlighting the impact exercise duration has on body composition change. It is well established that impact exercise can support gains in BMD; however the current data demonstrate a significant decrease in BMD in the high impact challenges. These findings suggest research is required to better understand body composition changes during ultra endurance.

### DIETARY COUNSELING INTERVENTION DECREASED CARDIOMETABOLIC RISK IN MALE HEAVYWEIGHT JUDO ATHLETES

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**Introduction** Male heavyweight athletes have excessive body fat which may increase cardiometabolic risk including insulin resistance, dyslipidemia and hypertension (Borchers et al., 2009). Abdominal fat especially visceral fat (VF) accumulation has been shown to play crucial roles in the development of metabolic syndrome (Matsuura et al., 1998). Therefore, the purpose of this study was to examine whether a dietary counseling intervention (DCI) can effectively decrease cardiometabolic risk of male heavyweight Judo athletes without reducing their performance. **Methods** Seventeen male Judo athletes who belonged to an over 100kg class participated in this study. They were divided into 2 groups such as DCI group (n=9; age 20.1±1.0 years, body weight (BW) 127.0±12.6 kg, %body fat (%BF) 28.1±3.6%, VF 119±32 cm<sup>2</sup>) and Control group (n=8; age 20.9±1.2 years, BW 124.2±2.4 kg, %BF 28.9±5.8%, VF 129±33 cm<sup>2</sup>). DCI group completed a 10-week dietary counseling using e-mail and personal interview by the certified Sports Dietitian which instructs them to have a well-balanced diet with proper caloric intake. VF was measured by magnetic resonance imaging and body composition was assessed by dual energy X-ray absorptiometry. Physical fitness including cardiorespiratory endurance and muscle strength were also examined. The statistical difference of before and after the DCI was examined by the paired t- test. **Results** After the intervention, both BW and VF significantly decreased by 4.2kg (3.3 %) and 10cm<sup>2</sup> (7.8 %) in DCI group, respectively, whereas fat-free mass or subcutaneous fat area did not change. Triglyceride (from 163±129 to 113±80 mg/dL, p<0.05), HOMA-IR (from 2.2±1.3 to 1.2±0.7, p<0.01), and systolic blood pressure (from 135±10 to 122±11 mmHg, p<0.01) were also significantly decreased. On the other hand, muscular strength including handgrip, back and leg strength as well as cardiorespiratory endurance level of both groups were maintained even after the weight loss. **Discussion** It was found that the 10-week DCI significantly lowered cardiometabolic risk without reduction of FFM, muscle strength as well as the cardiorespiratory endurance even after the weight loss. The previous study reported that a DCI including caloric restriction with exercise effectively decreased visceral fat and cardiometabolic risk in obese individuals (Straznicki et al., 2012). Therefore, proper dietary intervention may be effective to lower cardiometabolic risk even with small reduction of VF for heavyweight athletes. **Conclusion** This study suggests that DCI can effectively reduce cardiometabolic risk with reducing visceral fat for male heavyweight Judo athletes without influencing their physical performance. **References** Borchers JR, Borchers, JR, Clem, K L et al. (2009). *Med Sci Sports Exercise*. 41, 2105 - 2110. Matsuura F, Yamashita S, Nakamura T et al. (1998). *Metabolism*. 47, 929 - 933 Straznicki NE, Lambert EA, Grima MT et al. (2012). *Diabetes Obes Metab*. 14, 39 - 148. Contact hiromura@toki.waseda.jp

### THE ACUTE EFFECTS OF BEETROOT JUICE ON SUB-MAXIMAL EXERCISE EFFICIENCY AND SKELETAL MUSCLE METABOLISM IN RECREATIONALLY ACTIVE MALES

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**Introduction** Beetroot juice rich in inorganic nitrates (NO<sub>3</sub>) have been shown in some studies to decrease oxygen consumption (VO<sub>2</sub>) for a given workload i.e. increases efficiency. It has generally been assumed that the exercise efficiency effect of nitrates is due to an increased availability of nitric oxide (NO) since NO<sub>3</sub> can be reduced to nitrite (NO<sub>2</sub>) and then NO, especially under acidic and hypoxic conditions. In this pathway oral bacteria play a key role, and the use of antibacterial mouthwash has been shown to reduce some effects related with NO<sub>3</sub> such as a decrease in blood pressure. However this has not been examined in regards to exercise efficiency. Additionally, there is a lack of studies investigating the effects of NO<sub>3</sub> on important aspects of exercise metabolism such as glucose kinetics or muscle glycogen utilisation. Therefore, the main goal of this study was to investigate the effects of nitrates on skeletal muscle metabolism. **Method** Eight participants (age: 27 ± 4 yr, VO<sub>2peak</sub>: 46.3 ± 8.1 ml/kg/min) performed 3 trials; Placebo, Beetroot juice (BR) (~8mmol NO<sub>3</sub>), or BR + mouthwash (BR+MW) following a randomised cross over design. Two and a half hours after treatment participants exercised for 60 minutes on a cycling ergometer at 65% of VO<sub>2peak</sub>. Respiratory parameters (VO<sub>2</sub>, VCO<sub>2</sub> and RER) were analysed during exercise from 10-15 and 45-50 minutes. The stable isotope glucose tracer [6,6-2H] glucose was infused to determine glucose kinetics. Muscle biopsies were obtained prior to and immediately after exercise and analysed for glycogen, lactate, adenosine triphosphate (ATP), phosphocreatine (PCr) and creatine (Cr). Blood samples were obtained prior to, and during exercise and analysed for lactate, glucose, non-esterified fatty acids (NEFA), glucose isotope enrichment, and NO<sub>2</sub>. **Results** Plasma nitrite [NO<sub>2</sub>] increased significantly after the ingestion of BR, and the increase was attenuated with mouthwash. Despite this, there was no significant (p>0.05) effect of BR or BR+MW on oxygen consumption during exercise. There was also no difference in plasma glucose, glucose kinetics, lactate, NEFA, muscle glycogen utilisation, ATP, PCr and Cr between trials. **Conclusion** Despite a significant increase in plasma nitrite concentration after the ingestion of BR there was no effect on exercise VO<sub>2</sub>, glucose kinetics or muscle metabolites. Further research is required to clarify the importance of nitrate on exercise in humans.

### ONE WEEK OF BED-REST SUBSTANTIALLY REDUCES MUSCLE MASS AND INDUCES INSULIN RESISTANCE IN HEALTHY MALES

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**Background:** The recovery from illness or injury is generally accompanied by short periods (<1 week) of bed-rest. Whereas the functional and metabolic consequences of prolonged (> 1 month) bed-rest have been well-established, the impact of short-term bed-rest remains largely unexplored. The present study assessed the effects of one week of bed-rest on skeletal muscle mass, leg strength, and whole-body insulin sensitivity. **Methods:** Ten healthy males (23±1 y) were subjected to 7 days of strict bed-rest. Prior to and immediately following bed-rest, a DEXA scan, CT scan of the upper leg, and a hyperinsulinemic-euglycemic clamp were performed to assess lean body mass, quadriceps cross sectional area (CSA) and peripheral insulin sensitivity, respectively. Additionally, prior to and after bed-rest, an incremental cycle ergometer test and a 1-Repetition Maximum (1RM) test were carried out to determine VO<sub>2peak</sub> and maximal leg strength. **Results:** One week of bed-rest resulted in 1.4±0.2 kg loss of lean tissue mass (P<0.01) and a 3.2±1.0% loss of quadriceps CSA (P<0.01). Glucose infusion rates decreased from 62±6 to 42±3 μmol•kg FFM<sup>-1</sup>•min<sup>-1</sup>, representing a 29±5% decline in peripheral insulin sensitivity



( $P < 0.01$ ). Following bed-rest,  $VO_2$  peak and 1RM had declined by  $6.4 \pm 2.3\%$  ( $P < 0.05$ ) and  $6.9 \pm 1.4\%$  ( $P < 0.01$ ), respectively. Conclusion: One week of bed-rest substantially reduces muscle mass, leg strength, whole-body oxygen uptake capacity, and peripheral insulin sensitivity. Effective strategies should be designed to attenuate the loss of muscle mass and decline in metabolic health during short periods of muscle disuse.

### THE INFLUENCE OF BLOOD DONATION ON ENERGY CONTRIBUTION AND PACING DURING MIDDLE DISTANCE CYCLING

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Purpose Delivery of oxygen to the working muscles is vital for aerobic metabolism and when reduced, it has been observed to impair performance. However, its effect on pacing during middle distance self-paced events is unknown. The primary aim of this study was to investigate the effect of oxygen delivery on pacing and middle distance performance. Methods On six separate occasions, seven male cyclists ( $32.0 \pm 8.9$  y) completed an incremental cycling test followed 20 min by a four-minute self-paced cycling time trial (4MMP). The initial two sessions acted as a familiarisation and baseline testing after which 470 ml of blood was removed. The remaining tests were performed 24 h, 7 d, 21 d and 42 d following blood removal. During all 4MMP trials, power output, oxygen consumption ( $VO_2$ ), and aerobic and anaerobic energy contribution were determined. Results  $VO_{2max}$  measured during the incremental test decreased by  $7.03 \pm 4.71\%$  during the first 24 h following blood removal ( $P < 0.05$ ) but was not different from baseline in subsequent tests. Compared with baseline, PPO measured during the incremental test decreased by  $6.86 \pm 3.72$ ,  $4.61 \pm 1.62$ , and  $3.40 \pm 3.47\%$  at 24 h, 7 d and 21 d following blood removal, respectively ( $P < 0.01$ ). Average power output in 4MMP trial decreased by  $7.19 \pm 5.60$ ,  $6.01 \pm 8.36$  and  $4.15 \pm 6.31\%$  at 24 h, 7 d and 21 d following blood removal, respectively ( $P < 0.01$ ). Aerobic contribution during the 4MMP was  $4.70 \pm 4.14$ ,  $3.95 \pm 5.17$ , and  $4.27 \pm 10.06\%$  lower than baseline at 24 h, 7 d and 21 d, respectively ( $P < 0.01$ ). Anaerobic contribution was not different across any of the 4MMP trials ( $P = 0.91$ ). There was no difference in pacing observed across the 4MMP trials ( $P = 1.00$ ). Conclusion The results indicate that the removal of 470 ml of blood reduces aerobic energy contribution and decreases performance during self-paced exercise but does not alter pacing pattern. These findings support previous literature indicating that variation in pacing during middle distance events may be largely influenced by the distribution of anaerobic resources.

## Oral presentations

### OP-BN10 Motor learning, Coordination

#### POSTURAL THREAT INFLUENCES NEURAL CONTROL OF UPRIGHT STANDING IN YOUNG AND ELDERLY ADULTS

Johannsson, J., Duchateau, J., Baudry, S.

Université Libre de Bruxelles

Introduction: Postural control is associated with modulation of peripheral and descending drive converging onto soleus motor neurones (2). Most studies have shown, in young adults, a decrease of the Hoffmann (H) reflex amplitude when standing at the edge of an elevated platform compared with standing on the ground (1). This decrease in reflex loop excitability may reflect a shift to supraspinal control balance when increasing the height of the standing surface or the postural threat associated with standing at the edge of a platform. The suggested decrease in capacity of elderly adults to modulate spinal reflex (3) might place them in an unsafe situation when standing at the top of a stair. This study therefore investigated the influence of height and postural threat on spinal and corticospinal excitability in young and elderly adults. Methods: 12 young ( $25 \pm 1$  yrs) and 9 elderly ( $70 \pm 5$  yrs) adults participated in the study. Surface electromyogram (EMG) was recorded from soleus, gastrocnemius medialis and tibialis anterior. The H reflex was evoked in the soleus by stimulating the fibular nerve. The motor evoked potential (MEP) was recorded in the same muscle in response to transcranial magnetic stimulation elicited at an intensity of 120% of the active motor threshold. Three upright standing conditions were investigated consisting of standing downstairs, upstairs backing stairs and upstairs facing stairs. In addition to height, the latter condition was aimed at increasing postural threat by limiting stepping response strategy. Results: Age did not influence ( $p > 0.05$ ) the modulation of EMG, H-reflex and MEP between standing conditions described hereafter. Compared with downstairs, maximal H-reflex amplitude decreased when subjects stood upstairs facing stairs ( $-8.7\%$ ;  $p < 0.01$ ) but did not change when standing upstairs backing stairs ( $p = 0.31$ ). The MEP amplitude varies by less than 1% across standing conditions ( $p > 0.05$ ). Background EMG did not differ between standing conditions. Discussion: The decrease in H-reflex amplitude in absence of change in background EMG when standing upstairs facing stairs suggests an increase in presynaptic inhibition of muscle spindle pathway to decrease reflex activity that may impair balance in presence of postural threat (1). These results also indicate that elderly adults can still modulate muscle spindle pathway depending on standing conditions. The lack of change in MEP amplitude, however, does not support an increase in corticospinal contribution to control upright standing when postural threat is increased. References 1) Sibley et al. Hum Mov Sci 2007; 26:103-12. 2) Tokuno et al. Acta Physiol 2009; 195:385-95. 3) Tsuruike et al. Clin Neurophysiol 2003; 114:945-53. Study supported by the National Research Fund of Luxembourg (grant #9266321).

#### CONTRIBUTION OF VISUAL AND PROPRIOCEPTIVE INFORMATION IN POSTURAL CONTROL DIFFERS WITH AGE

Penzer, F., Duchateau, J., Baudry, S.

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Introduction Previous work revealed the importance of sensory inputs to control balance, with different contribution of vestibular, visual and proprioceptive information (Peterka 2002). Accordingly, the decline in the integrity of the sensory systems with ageing alters balance capacity (Maki et al. 1996). But the effects on the respective contribution of sensory information to control upright standing remain to be determined. To investigate the effect of age on the contribution of visual and proprioceptive information in the control of postural balance, young and elderly adults were compared while standing with different visual conditions before and after prolonged bilateral Achilles tendon vibration aimed at altering the proprioceptive information from leg muscles. Methods Fifteen young ( $22.9 \pm 1.6$  yrs) and fourteen elderly adults ( $70.1 \pm 7.6$  yrs) participated in this study. Prior to and immediately after 1 hour of Achilles tendon vibration (1-mm amplitude,

80Hz), subjects were asked to stand on a force platform with eyes open (REO) and closed (REC) and with a visual feedback (VFB) of their centre of pressure (CoP). CoP path length (CoPpath) was measured during 40-s trials in each visual condition. The Hoffmann reflex confirmed the efficacy of vibration in altering muscle spindle afferents in both groups. Results Before Achilles tendon vibration, CoPpath did not differ between age groups in REO ( $p=0.41$ ). It increased significantly in REC in both age groups, but to a greater extent in elderly (+25%,  $p=0.001$ ) than in young adults (+17%,  $p<0.001$ ). Compared with REO, CoPpath did not change significantly with VFB in young adults whereas it increased (+18%,  $p=0.007$ ) in elderly adults. After vibration, CoPpath increased in REO (+14%,  $p=0.029$ ) and REC (+18%,  $p=0.001$ ) whereas it did not vary with VFB ( $p=0.37$ ) in young adults. In contrast, Achilles tendon vibration did not influence CoPpath in any of the visual conditions in elderly adults. Discussion In agreement with previous work, elderly adults experienced more difficulties to stand stable without vision. In addition, this study indicates that visual feedback of CoP impairs balance stability only in elderly adults, whereas long-duration tendon vibration altered the control of upright standing solely in young adults. These results suggest that age-related impairments of the somatosensory system (Shaffer and Harrison 2007) decrease dependence to muscle spindle afferents and induce a shift toward a greater reliance on visual information to control balance in elderly adults. References Maki, Holliday, Topper (1994), *J Gerontol* 49, 72-84. Peterka (2002), *J Neurophysiol* 88, 1097-118. Shaffer, Harrison (2007), *Phys Ther* 87, 193-207. Study supported by the National Research Fund of Belgium (FNR-FNRS). Contact fpenzer@ulb.ac.be

### THE INFLUENCE OF AN EXTERNAL FOCUS OF ATTENTION VERSUS INTERNAL FOCUS OF ATTENTION WITH REGARD TO MOTOR LEARNING AND SKILL ACQUISITION FOR ANTERIOR CRUCIATE LIGAMENT INJURY PREVENTION.

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Introduction: Exercise programs aimed at preventing ACL injury may decrease injurious mechanics. Wulf suggests that motor task learning is maximized when an external focus of attention (EFA) versus internal focus of attention (IFA) is provided during skill acquisition. The effect of IFA and EFA instruction during ACL injury prevention programs has not been adequately studied. Objective: To compare the effect of EFA vs. IFA instruction on the change in magnitude of muscle activity during a 6-week neuromuscular exercise program designed to prevent ACL injury. It is hypothesized that subjects receiving EFA instruction would exhibit more desirable muscle activity patterns in muscles protective of the ACL compared to those receiving IFA instruction. Design: Pre-Post-test group comparisons. Setting: Research laboratory. Subjects: A convenience sample of 31 female recreational athletes ( $24.5 \pm 1.8$  years) with no history of knee injury/LE surgery were randomly assigned to 2 subject groups. Interventions: Subjects performed a series of exercises including neuromuscular trunk and lower strengthening, balance, plyometric, agility and jump training (Hewitt, Silvers) in 8 rotating stations 2x/week for 6 weeks. Groups 1 and 2 received IFA and EFA instruction, respectively, during implementation of the exercise program. Pretraining and posttraining muscle activity for the right vastus medialis (VM), vastus lateralis (VL), rectus femoris (RF), biceps femoris (BF), gastrocnemius (GS), gluteus medius (Gmed), and gluteus maximus (Gmax) were monitored with surface electromyography (EMG) during weight acceptance of a forward jump from a platform, and a right-cut maneuver. A linear envelope filtered at 10 Hz, normalized to % MVIC, determined magnitude of muscle activity for an average of 3 trials. Main Outcome Measures: Pre-post-training changes in integrated and peak EMG muscle activity (LEEMG) during weight acceptance of a forward jump and right-cut maneuver were analyzed between groups. One-tailed independent sample t-tests were performed with  $P<0.05$  set a priori. Results: There were no significant differences between groups for the forward jump. For the right cut, pre-post change in peak RF ( $6927 \pm 1.66$ ;  $-8686 \pm 1.17$  % MVIC;  $P<0.007$ ) was significantly less in Group 2 than Group 1. Changes in integrated RF ( $0.0767 \pm .151$ ,  $-0.053 \pm .141$  % MVIC,  $P<0.017$ ) and GS ( $1.22 \pm .22$ ,  $-0.0129 \pm .110$  % MVIC,  $P<0.03$ ), and peak VMO ( $1.23 \pm 4.26 - 1.08 \pm 2.33$  % MVIC,  $P<0.05$ ) and GS ( $1.01 \pm 2.06$ ,  $-2.79 \pm 1.45$  % MVIC,  $P<0.04$ ) during the right cut were significantly greater in Group 1 than Group 2. Conclusions: EFA instruction vs. traditional cues (IFA) may provide some benefit when implementing an ACL injury prevention program but may not be generalizable across all ages, motor tasks and muscles. Future research should examine whether a specific type of instruction affects motor learning, as well as motor skill retention.

### GENERALISED JOINT HYPERMOBILITY IN ELITE LEVEL ADOLESCENT ATHLETES – BENEFICIAL OR PROBLEMATIC IN RELATION TO INJURY, PAIN, PHYSICAL FUNCTIONING AND QUALITY OF LIFE?

Schmidt, H., Lykke Pedersen, T., Nicholson, L., Engelbert, R.H.H., Juul-Kristensen, B.

*University of Southern Denmark*

Introduction Generalised Joint hypermobility (GJH) affects injury frequency, pain, physical functioning and health related quality of life (HRQoL) in the general population, but such relations are unknown in adolescent elite level athletes. The aim was to investigate whether adolescent elite level athletes with GJH had higher injury and pain frequency, and lower physical functioning and HRQoL than non-GJH (NGJH). Methods Totally 132 adolescents (36 males; 96 females), aged 14.01 (0.88) years, participated ( $n=22$  ballet dancers,  $n=57$  team gymnasts,  $n=53$  team handball players). GJH was defined by the Beighton score (BS) (GJH4:  $BS \geq 4/9$ , GJH5:  $BS \geq 5/9$ , GJH6:  $BS \geq 6/9$ ). Two questionnaires were used, comprising injuries during latest month, and lower extremity related physical limitations and HRQoL (RAOS-Child questionnaire). Dynamic and static motor competence was tested with one-leg hop for distance (OLHD), three consecutive cross-over hops (COH), and four postural sway tests (bilateral and unilateral stance with open (1OE, 2OE) and closed eyes (2CE, 1CE)) measured as sway length, Center of Pressure Path Length (COPL), from December 2013-March 2014. Results Prevalence of GJH4, GJH5 and GJH6 was 27.3%, 15.9% and 6.8%, respectively, with the highest prevalence in ballet and team gym. There was no significant difference between GJH and NGJH in injury frequency, pain and HRQoL. However, in GJH5, RAOS symptom score was lower ( $p=0.027$ ), and hop length (OLHD) shorter ( $p=0.032$ ). COPL in bilateral stance was increased in all GJH groups (2OE; GJH4:  $p<0.001$ ; GJH5:  $p<0.001$ ; GJH6:  $p=0.015$ . 2CE; GJH4:  $p<0.001$ ; GJH5:  $p<0.001$ ; GJH6:  $p=0.014$ ). In unilateral stance, only GJH4 had increased COPL (1OE; GJH4:  $p=0.022$ ), and GJH5 had fewer completed trials (1CE;  $p=0.006$ ) than NGJH. Conclusion GJH was most prevalent in ballet dancers. Elite level adolescents with GJH were not more prone to injury, pain or decreased HRQoL than NGJH. In GJH symptoms related to lower limb function were more prevalent. Those with GJH demonstrated increased sway in bilateral stance and completed fewer unilateral sway trials. Further studies of the longitudinal consequence of GJH are indicated. Contact bjuul-kristensen@health.sdu.dk

## NEITHER VOLUNTARY MUSCLE ACTIVATION NOR STRETCH TOLERANCE IS A LIMITING FACTOR TO ANKLE JOINT RANGE OF MOTION

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**Introduction** Joint range of motion (ROM) is a multi-factorial attribute of flexibility, including extensibility of soft tissues that cross and/or cover the joint. Previous studies proposed significant impact of muscle activity triggered upon passive stretch (Osternig et al., 1987), and the "stretch tolerance" (Magnusson et al., 1996a ; 1996b) as major limiting factors of ROM. However, direct evidence is scarce for these factors. The aim of this study was to examine these contributions by comparing the conscious and anaesthetized conditions. **Methods** Five Subjects (four males, one female) who had orthopaedic surgery operation of upper extremities participated in this study. Before operation (conscious) and under mask anaesthesia (fully unconscious with muscle relaxant) conditions, ankle joint angle, medial longitudinal arch angle, and elongation of the muscle belly of the gastrocnemius medialis (dMus) during maximally tolerable passive dorsiflexion (matched for the two conditions by the force applied to the ankle joint into dorsiflexion) were measured, and Achilles tendon elongation (dTen) was estimated (based on the formula by Grieve et al., 1978). **Results** There were no significant differences between conscious and unconscious conditions for ankle joint angle and elongation of dMus and dTen. The medial longitudinal arch angle reached a significant level toward decrease in unconscious compared to conscious condition (116 vs. 123 deg,  $p < 0.05$ ). Although not significant, in four out of five subjects, ankle joint ROM was smaller in unconscious than in conscious condition. **Discussion** Our finding is in sharp contrast to the notion that the joint range of motion is largely affected by the amount of voluntary activation of the muscles under stretch (Magnusson et al., 1996b). Our finding also does not support the idea that we avoid injuries by actively resisting excessive joint loading into the ROM limit (Alter, 2004). The present study discards voluntary muscle activation and stretch tolerance from the major candidates limiting ankle joint flexibility. **References** Alter. (2004) Science of flexibility. Human Kinetics. Grieve et al. (1978) Biomechanics VI-A, 2: 405-412. Johns and Wright. (1962) J Appl Physiol, 17: 824-828. Kawakami et al. (2003) Jpn J Phys Fitness Sports Med, 52 Suppl: 149-156. Magnusson et al. (1996a) Arch Phys Med Rehabil, 77: 373-378. Magnusson et al. (1996b) J Physiol, 497: 291-298. Osternig et al. (1987) Am J Phys Med, 66: 298-307. Contact ayumi.1749-hamds@uri.waseda.jp

## Oral presentations

### OP-SH18 Sport participation, development and exercise

#### INQUIRY BASED LEARNING AS PEDAGOGICAL APPROACH TO ENHANCE REFLECTIVE PRACTICE IN PHYSICAL EDUCATION TEACHER EDUCATION

Østergaard, L.D.

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**Introduction:** During the last decades, reflections have gained attention as a tool for teachers to improve and qualify physical education (PE) teaching (Standal & Moe, 2013). However, research has shown that reflective practice in PETE as well as in PE is experienced as a difficult process (ibid.). In this project inquiry based learning (IBL) is proposed as a pedagogical approach to promote students' reflective practice in PETE. **Methods:** IBL was implemented over a period of 10 weeks in a PETE training program where 32 students were given challenges related to the PE curriculum in secondary school. Data were collected in the form of audio and video recordings of students' reflections and actions during the unit. Further, the students' written reflections on the challenges were collected. The data were analyzed by interpretative phenomenological analysis (Palmer, Larkin, de Visser, & Fadden, 2010) in order to identify and extract common themes and patterns. **Results:** The analysis of the data revealed that during the IBL approach the students reflected on both the inquiry approach as a methodology, the current challenges they were given, and their own practice as coming PE teachers. Second order critical reflections were seen mostly in the phases of hypothesizing and evaluation. **Discussion:** In this project IBL seems to work as the students during the unit showed signs of questioning, critical thinking and problem solving. These results are similar to results from other projects introducing IBL (Padraig & McLoughlin, 2009). Critical reflections were mostly seen as students' thinking about their coming practice as PE teachers. In general the IBL approach stimulated the students to use interpersonal reflections as transformative, challenging-the-exciting, and critical forms of 2nd order reflections (Wackerhausen, 2009), which are important skills to acquire as the students in their future practice as PE teachers need to be critical and reflective to optimize, plan and design motivating PE courses. **References:** - Padraig, M., & McLoughlin, M. M. (2009). Inquiry-Based Learning: An Educational Reform Based Upon Content-Centred Teaching. Paper presented at the Annual Meeting of the American Mathematical Society, Washington, DC. - Palmer, M., Larkin, M., de Visser, R., & Fadden, G. (2010). Developing an Interpretative Phenomenological Approach to Focus Group Data. Qualitative Research in Psychology, 7(2), 99-121. - Standal, O. F., & Moe, V. F. (2013). Reflective Practice in Physical Education and Physical Education Teacher Education: A Review of the Literature since 1995. Quest, 65(2), 220-240. - Wackerhausen, S. (2009). Collaboration, professional identity and reflection across boundaries. Journal of Inter-professional Care, 23(5), 455-473.

#### 'THERE ARE NO RIGHT OR WRONG WAYS' - PE TEACHERS USING EXPRESSIVE DANCE AS A LEARNING TOOL WITHIN PHYSICAL EDUCATION.

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**Introduction** It is argued that the use of expressive dance can question gender stereotypes in physical education (PE). Dance has been a part of the PE curriculum in several countries for a long time. In spite of this, studies demonstrate that teaching dance in PE is rare and aesthetic perspectives on moving bodies are absent. Therefore, the purpose of this research is to investigate PE teachers' experiences of using expressive dance as a learning tool and to explore whether dance can help broaden understandings of potential and possibilities within PE. **Method** Pre and post semi structured interviews have been used to 'give voice' to PE teachers' experiences in combination with videotaped observations during a dance theme in PE. Data collection focused on teachers' actions and narratives, while also taking the whole didactic system into account; the knowledge intended to be learned, teachers' strategies and the context (Amade-Escot 2006). The empirical material consisted of eight interviews with four PE teachers and 24 observed PE lessons. **Results** PE teachers described a

feeling of freedom and that teaching expressive dance has broadened their perceptions of what and how students learn. Rather than imitating movements the focus changed to the students themselves, who created and reflected on their movements. Teachers 'discovered' new students, other than those who tended to dominate the sport teaching. Teachers also recognized that boys and girls can and do co-operate and that girls take as much physical space as boys do. Discussion Underscoring Dewey's (1934/2005) thoughts of bodies in transaction in social, cultural and physical context, feminist theory (Sullivan 2001) is used to expand the thinking about the gendered body, such as the role of habit and meaning. Expressive dance as non-competitive and without predetermined movements can challenge a masculine-coded subject. Such a discussion can add new dimensions to debates on the nature and purposes of a sustainable PE for now and in the future. References Amade-Escot, C. (2006). Student learning within the didactic tradition. In: D. Kirk, D. Macdonald & M. O'Sullivan (eds.), *The handbook of physical education*. London: Sage Publication, pp. 347-365. Dewey, J. (1934/2005). *Art as experience*. New York: Penguin Group. Sullivan, S. (2001). *Living across and through skins. Transactional bodies, pragmatism and feminism*. Bloomington and Indianapolis: Indiana University Press. torun.mattsson@mah.se

## PHYSICAL LITERACY THROUGH DANCE EDUCATION

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This study is an action research to investigate the inclusion of dance education in the PE curriculum of a female secondary school in Hong Kong, in order to maximize students' learning outcomes through PE lessons. Teaching dance is regarded as a child-centered context for learning (Brown, 2014). It facilitates the integration of developing our mind and body (Brown, 2014), and fosters creative and rational thinking (Byeon, 2012). Numerous studies also elaborate the values of dance education in school curriculum. Participants of this action research are from the junior and senior forms of a female secondary school in Hong Kong. The PE teacher conducts dance lessons in two intervention cycles. The teaching approach is adopted as structured, open and reflective as Henley (2014) suggested. Participants are asked to complete the Intrinsic Motivation Inventory (IMI), developed by Ryan (1982) and his colleagues from the Rochester Motivation Research Group (McAuley, Duncan & Tammen, 1989), in both the first and second intervention cycles to determine the levels of intrinsic motivation in terms of interest-enjoyment, perceived competence, effort and tension throughout the dance lessons. Moreover, interviews with PE teacher and participants are organized to collect the qualitative data on students' enjoyment and social aspects in dance lessons. When designing PE curriculum, physical educators would consider its scope, sequence and balance of the teaching contents, therefore this action research is served as an example for including dance education in the PE curriculum to maximize students' all-round development through the participation in dance activities in PE lessons. Further studies are suggested to examine dance education in male schools or coeducational schools. Brown, A.K. (2014). A model for dance education: promoting personal voice and communal learning. *International Journal of Education through Art*, 10(2), 179-188. Byeon, J.K. (2012). Dance education in Korea. *Journal of Physical Education, Recreation and Dance*, 83(1), 27-31. Henley, M. (2014). Sensation, perception, and choice in the dance classroom. *Journal of Dance Education*, 14, 95-100. McAuley, E., Duncan, T. & Tammen, V.V. (1989). Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: a confirmatory factor analysis. *Research Quarterly for Exercise and Sports*, 60(1), 48-58. Ryan, R.M. (1982). Control and information in the intrapersonal sphere: An extension of cognitive evaluation theory. *Journal of Personality and Social Psychology*, 43, 450-461.

## CHALLENGES FOR INTERVENTION RESEARCH IN HEALTH AND LIFESTYLE RESEARCH – A SYSTEMATIC META-LITERATURE REVIEW

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Introduction Health and well-being are two concepts that are widely discussed within today's society. A major perspective in health and lifestyle research is to investigate what determinants are associated with health. When it comes to the delivery of health interventions several different approaches have been suggested. Methods The meta-synthesis was chosen for synthesis of research studies using a health and lifestyle the review format and analyse meta-questions. The process included the following five phases: 1. Literature search for articles. 2. Selection of relevant articles after repeated reading and appraisal of the articles. 3. Extraction of data from each article and creating a list of findings as key phrases, ideas and concepts for each individual study. 4. Determining how the findings of the selected studies are related and translating findings into one another. 5. Synthesizing the translations to produce a new theoretical interpretation. Results The search yielded a total of 561 unique citations and finally 24 citations remained. Of those 11 studies focused on health determinants, while 13 focused on interventions for health promotion. The meta-synthesis led to four recommendations for the design of future intervention studies. (1) scientific disciplines should collaborate in the design, implementation and evaluation of the study. (2) to use theoretical frameworks that focus on health determinants and to apply longitudinal studies with a repeated measures design. (3) involve behavioral interventions. (4) to design face-to-face intervention studies. Discussion Determinants was related to a physical active lifestyle, more specifically high quality school programs for physical education. It could be a starting point for a nationwide approach of daily physical activity in whole society. In all intervention studies physical activity behaviors were included as outcome or intervention program. It is therefore speculated that physical activity behavior could be discussed as one mediator between health determinants and health outcomes. References Bailey, R. (2006). Physical education and sport in schools: a review of benefits and outcomes. *Journal of School Health*, 76, 397-401. Dodge, R., Daly, A., Huyton, J., & Sanders, L. (2012). The challenge of defining wellbeing. *International Journal of Wellbeing*, 2, 222-235. Kahn, E. B., Ramsey, L. T., Brownson, R. C., Heath, G. W., Howze, E. H., Powell, K. E., & Corso, P. (2002). The effectiveness of interventions to increase physical activity: A systematic review. *American journal of preventive medicine*, 22, (4), 73-107. Pateron, B.L., Thorne, S., Canam, C., Jilings, C., (2001). *Meta-Study of Qualitative Health Research: A Practical Guide to Meta-Analysis and Meta-Synthesis*. Sage, Thousand Oaks, CA. Södergren, M. (2013). Lifestyle predictors of healthy ageing in men. *Maturitas*, 75, 113-117. Corresponding author email: Lars.Kristen@hh.se

## THE EFFECTS OF PHYSICAL ACTIVITY IN PRIMARY SCHOOLS ON ACADEMIC PERFORMANCE

Collard, D., Boutkan, S.1, Grimberg, L.2, Lucassen, J.1, Breedveld, K.1

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Introduction Increasingly, articles and policy documents are suggesting that sport and physical activity have an effect on academic performance. At the request of the Dutch Ministry of Education, Culture and Science insight was provided in the direction of this relationship

(positive, negative or neutral), but also whether there is a causal effect. It is also relevant to look at the body of evidence for this relationship (number of studies). Therefore we did a survey into the scientific literature on the relationship between sport and physical activity and (determinants of) academic performance. Methods To ensure that the most important literature is included in the summary, three methods were used. Firstly, known literature was consulted and an additional research was done in electronic literature databases (Pubmed, Psychinfo). Secondly, Dutch experts in this field were asked to supply input. They were asked to name the most important literature on the relationship between sport and physical activity at school and the determinants of academic performance. In addition, the literature references of important included articles have been verified. The research focused on the relationship between sport and physical activity and academic performance of primary school children. In addition, also the relationship between sport and physical activity and the determinants of academic performance were included, such as brain structure and executive functions (attention, concentration), motor skills, fitness and social behaviour. Results Results show that it is not (yet) clear whether there is a positive causal relationship between sport and physical activity at school and academic performance. Results are inconclusive and better quality and long-term studies are needed. What is clear is that sport and physical activity at school has no negative effect on academic performance. It should be noted that sport and physical activity clearly has positive effects on motor skills and complex movement skills, fitness, brain structure and executive functions. Evidence for the other relationships is still light or weak. Discussion Results show that there are some limitations in the research on the causal relationship between sport and physical activity and academic performance are described below. Firstly, there is insufficient understanding of the mechanism that explains the relationship between sport and physical activity and academic performance. Besides that, there is also insufficient understanding of the frequency, duration, intensity and type of sport or physical activity at school that contribute to improving academic performance Contact: d.collard@mulierinstituut.nl

12:00 - 13:15

## Plenary sessions

### PS-PL03 EXERCISE, ENERGY INTAKE, BRAIN HEALTH AND WELL BEING

#### ENERGY INTAKE AND EXERCISE AS DETERMINANTS OF BRAIN HEALTH AND VULNERABILITY TO INJURY AND DISEASE

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Humans evolved in environments where food was not continuously available, and so possess robust adaptive physiological and behavioral responses to periods of food scarcity. Emerging research in this Laboratory and elsewhere has shown that intermittent energy restriction (IER; for example fasting for a period of 24 hours several times each week) and vigorous exercise can increase numbers and strength of synapses and can enhance brain function (cognitive and sensory – motor performance) and mood. We find that the general mechanism by which IER and exercise benefit neurons is by challenging them by increasing their activation state and energy demand, which results in a coordinated engagement of signaling pathways that promote neuroplasticity and cellular stress resistance. The pathways activated by exercise and IF include those involving brain-derived neurotrophic factor (BDNF), mitochondrial biogenesis, DNA repair and removal of oxidatively damaged proteins and organelles (autophagy). Peripheral changes in energy metabolism that occur during fasting and exercise may also contribute to their beneficial effects on the brain. In this regard, the depletion of glycogen stores in the liver triggers the mobilization of fatty acids from fat cells and the production of ketone bodies. Ketone bodies such as beta-hydroxybutyrate provide an alternative energy source for neurons and may also activate signaling pathways that enhance the ability of the brain to cope with stress. Our studies in animal models of chronic neurodegenerative disorders (Alzheimer's and Parkinson's diseases) and acute brain injury (stroke and severe epileptic seizures) demonstrate robust neuroprotective and neurorestorative effects of IER. IER protects the brain by bolstering antioxidant defenses and protein chaperone levels, and by suppressing inflammation. The implications of these findings for strategies for optimizing brain function and reducing the risk of neurodegenerative disorders will be described. Acknowledgement: Supported by the intramural research program of the National Institute on Aging.

#### CAN EXERCISE AND PHYSICAL ACTIVITY OPTIMISE THE WELLBEING OF POPULATIONS?

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Existing evidence suggests that engagement in structured exercise programmes or lifestyle physical activity is associated with better physical and mental health. Much of the evidence to date has focused on examining the effects of exercise and physical activity on physical and cognitive function, and psychological disorders such as depression and anxiety. Studies have predominantly assessed a range of psychological and wellbeing measures in relatively small groups of individuals within settings such as worksites, education, clinical populations, or within specific age groups (e.g. older adults). There is a very limited body of evidence examining the role of exercise and physical activity in optimising community- or population-level health. This presentation will provide an overview of the current evidence, and will examine the complexities and challenges inherent in this area of research, including the: 1) multitude of outcome measures used to represent 'wellbeing'; 2) difficulty in controlling for the plethora of personal, social, economic, and environmental factors that can strongly influence wellbeing; and 3) lack of methodological approaches capable of elucidating physiological and psychological mechanisms explaining changes in wellbeing. In addition, examples of funded initiatives working to integrate multi-disciplinary and multi-level approaches to optimising the wellbeing of populations will be discussed.

15:00 - 16:00

## Mini-Orals

## MO-PM37 Training and Testing: Fatigue and neuromuscular physiology

**BRAIN OXYGENATION, CARDIOVASCULAR RESPONSES AND RUNNING PERFORMANCE WEARING A COMPRESSION GARMENT**

Leoz-Abaurrea, I., Santos-Concejero, J., Grobler, L., Engelbrecht, L., Aguado-Jiménez, R.

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**Introduction** The effectiveness of wearing CGs during exercise has been questioned in the majority of studies, not finding differences in cardiorespiratory, thermoregulatory or metabolic during submaximal and maximal exercises (1). Despite previous physiological factors, there is an amount of evidences supporting that the central nervous system (CNS) is the limiting factor of exercise performance (2). Whole body exercise provokes central fatigue or the inability of the CNS to recruit the muscles involved in the exercise, and this is thought to be due to perturbations of metabolism and cerebral oxygenation (3). The latter, has never been studied wearing an upper body compression garment (UBCG), which could give to authors a better physiological vision on the use of CGs in the future. Hence, the aim of the present study was to analyse the physiological and performance responses of wearing an UBCG during a running performance test until exhaustion. Further, we would like to add novel data regarding the haemodynamic responses of the brain for a better understanding of the effects of CGs during exercise. **Methods** Ten recreational male runners (mean  $\pm$  SD: age  $23 \pm 3$  yrs;  $VO_{2max}$   $56 \pm 5$  ml  $\cdot$  kg $^{-1}$   $\cdot$  ml $^{-1}$ ) completed two identical sessions wearing either an UBCG (1-3 mmHg) or conventional running T-shirt (CON) in an ambient temperature of  $20 \pm 1$  °C and  $54 \pm 7\%$  rh. Testing consisted of running 45 min at 60% of peak treadmill speed (PTS) followed by a time to exhaustion (TTE) at 80% of PTS and 10 min recovery. Core temperature (Tcore), cardiorespiratory responses and brain oxygenation were measured during the test. **Results** Wearing the UBCG resulted in an impaired running performance ( $P=0.045$ ) probably due to a significantly higher ( $P=0.01$ ) respiratory exchange ratio (RER), a meaningfully higher plasma lactate ( $9.1 \pm 1.7$  vs.  $7.8 \pm 2.1$  mmol $\cdot$ L $^{-1}$ ) and a significantly lower ( $P=0.014$ ) cerebral blood flow (CBF) expressed in normalised total haemoglobin index (nTHI) at TTE. Conversely, a significantly lower Tcore was observed wearing the UBCG at TTE ( $P=0.041$ ). During recovery higher ( $P < 0.05$ ) heart rate, lactate and respiratory frequency values were recorded in the UBCG, whereas Tcore remained lower ( $P=0.002$ ). **Discussion** Although wearing a heat dissipating UBCG reduced Tcore during a running performance test, it incremented the ventilatory mechanical workload (expressed in RER) and plasma lactate concentrations, and reduced the CBF (expressed in brain nTHI) resulting in a decline in performance in comparison to CON. Further, these physiological differences were accentuated during recovery between garments. Thus, wearing an UBCG increased cardiovascular and respiratory responses and affected running performance. **References** 1. MacRae BA et al. (2012) Pressure and coverage effects of sporting compression garments on cardiovascular function, thermoregulatory function and exercise performance. 2. Kayser B (2003) Exercise starts and ends in the brain. 3. Rasmussen P et al. (2010) Reduced muscle activation during exercise related to brain oxygenation and metabolism in humans

**EXERCISE-INDUCED MUSCLE DAMAGE MARKERS DURING A FAMILIARIZATION PROTOCOL TO ECCENTRIC CYCLING**

Tornaghi, M.1, Bosio, A.1, Ferioli, D.1, Morelli, A.1, Martin, D.T.2, Menaspà, P.2,3, Fell, J.4, Rampinini, E.1

*1:Mapei Sport (Olgiate Olona, Italy), 2:AIS (Canberra, Australia), 3:ECU (Perth, Australia), 4:UTAS (Tasmania, Australia)*

**INTRODUCTION** Subjects unaccustomed to eccentric (ECC) exercise can experience muscle damage (MD) and related side effects (decreased resistance and endurance performance) the days following exercises involving ECC contractions. Aim of this study was to measure delayed onset muscle soreness (DOMS), creatine kinase (CK), maximal voluntary contraction (MVC), voluntary activation (VA) and neuromuscular functions (NMF) of the quadriceps during a familiarization period to ECC cycling. **METHODS** Eight amateur cyclists completed 11 sessions (2/week) of ECC. Each session consisted in alternating low (40%) and high intensity ECC (50-120% of aerobic PPO) on a custom-built cycle ergometer. The workload increased weekly and the last week was for tapering. At each session heart rate (HR) and RPE were measured. DOMS (0-10) asked at 24 and 48 hours post sessions. Once a week CK, MVC, VA and NMF were measured Pre and Post session. **RESULTS** Average HR during ECC was different ( $p=0.012$ ) throughout the familiarization period and a strong trend was seen for RPE ( $p=0.058$ ). These variables tended to match the weekly increase of the workload. CK was stable on normal values during the period. Average DOMS<sub>24</sub> ( $2.9 \pm 2.0$  week1 and  $0.1 \pm 0.4$  week6) was higher (m.e. of Time  $p=0.002$ ) than DOMS<sub>48</sub> ( $1.6 \pm 1.8$  week1 and  $0.1 \pm 0.4$  week6) and overall tended to decrease (m.e. of Weeks  $p=0.098$ ) during the familiarization. Baseline MVC and VA did not vary throughout the familiarization period and a similar pattern was found for Pre-Post ECC % changes. However, after the session examined, a strong trend ( $p=0.053$ ) towards a MVC reduction at Post vs Pre was present. Only baseline Peak Twitches (PT) at 1Hz tended to be higher during the last 3 sessions of the familiarization compared to the earlier session. PT % decrements on the last session were lower compared to the previous sessions at 1, 10, 100 Hz. PT % decrement was found lower on session 2 compared to 1 for stimulation at 1Hz. **DISCUSSION** Evidence from the present study suggests that the criteria used during the 6 weeks of familiarization to ECC seem appropriate to decrease the main markers of muscle damage. It is interesting to emphasize that none decrease of baseline MVC and NMF (the most likely cause of performance decline in presence of MD) was present in spite of a continuous increase of the ECC workload throughout the familiarization. A decrease of DOMS (the most annoying sign of MD) towards its complete absence might be an advantage also from a perceptual point of view. **REFERENCES:** Warren GL et al. (1999). Sports Med, 27(1):43-59 Twist and Eston (2009). Eur J Appl Physiol, 105(4):558-67 Contact: Michele.Tornaghi@mapeisport.it

## EFFECTS OF DIFFERENT RECOVERY INTERVENTIONS FOLLOWING A HALF MARATHON ON MARKERS OF FATIGUE AND RECOVERY IN RECREATIONAL RUNNERS

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**Introduction** Following half-marathon running an acute state of fatigue will occur, reflected by mechanisms from the central nervous system (e.g. impaired central motor drive) to the muscle cell itself (e.g. muscle damage and systemic inflammation) (Ament & Verkerke, 2009). Athletes, therefore, use different recovery interventions in an effort to speed recovery and to resume their normal training schedule in the shortest possible time (Hauswirth & Mujika, 2013). However, research on the efficiency of recovery interventions following endurance events is inconsistent and limited. Therefore, the aim of this investigation was to assess the effects of active recovery, cold-water immersion and massage after a half-marathon on markers of fatigue and recovery in runners. **Methods** 46 well-trained male athletes (age:  $30.0 \pm 10.9$  years) completed a half-marathon, followed by one of four 15 min recovery interventions. For the assignment to either active recovery, cold-water immersion, massage or passive recovery, runners were matched according to age and performance. Creatine kinase (CK), C-reactive protein (CRP), countermovement jump ability (CMJ), and delayed onset muscle soreness (DOMS) were evaluated before the half-marathon (pre), after the recovery intervention (postrec) and 24 h after the half-marathon (post24). Results Except for CMJ, no significant intervention x time interaction was found for markers of fatigue and recovery. After the half-marathon, runners in all groups showed increased serum CK (pre:  $248 \pm 194$  U•l<sup>-1</sup>; postrec:  $383 \pm 178$  U•l<sup>-1</sup>; post24:  $701 \pm 443$  U•l<sup>-1</sup>) and CRP concentrations (pre:  $1.18 \pm 2.19$  mg•l<sup>-1</sup>; post24:  $3.94 \pm 2.46$  mg•l<sup>-1</sup>) as well as DOMS (pre:  $1.0 \pm 1.4$ ; postrec:  $4.6 \pm 2.3$ ; post24:  $4.4 \pm 2.7$ ). In addition, cold-water immersion led to an acute decrease in CMJ postrec ( $-5.4 \pm 2.5$  cm). **Discussion** The main findings of the study were that a half-marathon induces muscle damage and a systemic inflammatory response. This is in line with previous research showing sustained inflammatory responses and muscular stress following endurance exercises (Byrne, Twist & Eston, 2004). Furthermore, the results suggest that none of the recovery interventions as applied in our study is able to contribute to a faster recovery during the first 24 hours following a half-marathon compared to passive rest. In addition, when using recovery interventions between subsequent events at the same day, coaches and athletes must be aware that cold-water immersion leads to an acute decline in performance. **References** Ament, W. & Verkerke, G.J. (2004). *Sports Med*, 39(5), 389-422. Byrne, C., Twist, C. & Eston, R. (2004). *Sports Med*, 34(1), 49-69. Hauswirth, C. & Mujika, I. (2013). Champaign, IL: Human Kinetics.

## METABOLIC PROFILE OF BODY MASS-BASED SQUAT EXERCISE IN HEALTHY YOUNG MEN.

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**Purpose:** Training modality with body mass-based exercise is known to be effective for enhancing muscular strength in children, middle-aged and elderly individuals (Yoshitake et al., 2011; Takai et al., 2013), and muscular activities during the body mass-based exercise depend on the strength-capacity of the participant (Fujita et al., 2011). However, there is little information concerning aerobic metabolic profile of physiological response for the body mass-based exercise. Thus, the present study aimed to quantify the aerobic metabolism during body mass-based squat exercise. **Method:** Eight healthy young men ( $23.5 \pm 4.4$  years,  $171.7 \pm 4.8$  cm,  $69.2 \pm 7.9$  kg) participated in this study. The subjects performed body-mass based parallel squat exercise 200 times at a pace of once every 3 s. During the exercise, blood lactate (fingertip), electromyograms (EMGs) from vastus lateralis (VL), rectus femoris (RF), vastus medialis (VM), biceps femoris (BF), and gluteus maximus (GM) muscles, oxygen uptake (breath-by-breath), and heart rate (ECG) were measured. The EMG amplitudes during the body mass-based squat exercise were normalized to those during maximal voluntary contraction (EMGmax), and expressed as % EMGmax. All data were analyzed, and averaged over once every 10 times (N10-N200). **Results:** Oxygen uptake was higher in N20 than in N10, and in N30 than in N20, but no significant differences were found in the other combinations. Mean heart rate was lower in N10 than in N30 and N40. Blood lactate at the 10th trial was lower than at the 40th trial. After the 40th trial, no significant difference was found in each of oxygen uptake, mean heart rate and blood lactate. There were no significant differences in the % EMGmax across times and muscles. Heart rate was highly related to the blood lactate concentration ( $r = 0.974$ ,  $p < 0.05$ ) and oxygen uptake ( $r = 0.933$ ,  $p < 0.05$ ) during body-mass based squat exercise. Oxygen uptake was highly related to blood lactate concentration ( $r = 0.941$ ,  $p < 0.05$ ). These results suggest that the execution of the body-mass based parallel squat exercise depends on aerobic metabolism if it is continued for 2 minutes and over (> 40 times). In addition, the metabolic equivalent during the exercise after 2 minutes corresponded to 6.3 METs. **Conclusion:** The current results indicate that body mass-based squat exercise at a pace of once every 3 s may be steady state in oxygen uptake, heart rate and blood lactate after the 40th trial. **Reference:** Yoshitake et al (2011) *Int J Sports Med*. 2011, 32 (12):924-8 Takai et al (2013) *J Sports Sci Med*. 2013 12 (1):60-65. Fujita et al (2011) *Med Sci Sports Exerc*, 1994, 69:132-319. Contact: haramura@nifs-k.ac.jp

## PHYSIOLOGICAL RESPONSES TO TWO CONSECUTIVE SIMULATED TAEWONDO MATCHES <4X1.5 MIN> IN ELITE YOUNG ATHLETES

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**Introduction** The aim of the present study was to examine the physiological impact of two consecutive simulated taekwondo matches, each consisting of four 1.5-min rounds, with 1 min break among rounds and 30 min break between matches, in elite young athletes. **Methods** Fourteen national level taekwondo athletes (four girls, age 13.1 yrs, height 157 cm, body fat 15.1%) participated in the present study. They performed two simulated matches; countermovement jump (CMJ, Optojump, Italy) and the sum of right and left handgrip muscle strength (Takei, Japan) were recorded before (PRE) and after the first match (POST1), and after the second match (POST2). Rate of perceived exertion (RPE) was recorded with the 6-20 Borg scale and lactate was measured 3-5 min after each match. Heart rate was monitored continuously, and mean HR (HRmean) and peak HR (HRpeak) were recorded. **Results** A one-way repeated measures ANOVA revealed significant differences in CMJ ( $p=0.003$ ,  $\eta^2=0.44$ ) among PRE, POST1 and POST2 (28.2, 30.4 and 30.1 cm, respectively), but not in handgrip strength (59.6, 56.4 and 58.6 kg,  $p=0.135$ ,  $\eta^2=0.15$ ). A paired-samples t-test did not show any difference between the two matches in lactate (7.9 vs. 7.4 mmol.L<sup>-1</sup>, respectively), RPE (13.1 vs. 13.4), HRmean (182 vs. 182 bpm) and HRpeak (199 vs. 199 bpm). **Conclusions** Based on these findings, it was concluded that 30 min break between two simulated matches (4x1.5 min) allowed participants to fully recover as the three indices of exercise intensity (lactate, RPE and HR) indicated similar workload for the two matches. Contact pade@mail@hotmail.com

**COMPARISON OF METHODS TO IDENTIFY THE ANAEROBIC THRESHOLD ON A BICYCLE ERGOMETER**

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*Charles University, Faculty of Physical Education and Sport*

The aim of this study was to compare five current different AT estimations on a bicycle ergometer. Ten trained triathletes participated in this study (age  $35.89 \pm 7.94$  years, body height  $181.83 \pm 6.52$  cm, body weight  $80.65 \pm 6.53$  kg). We calculated five AT using different proposed methods: AT1 - intensity corresponds to ventilatory threshold (V-slope method), AT2 - intensity corresponds to a first lactate rise (Free Freiburg (Simon) threshold), AT3 - Conconi test, AT4 - intensity corresponds to 95% of 20 min of the time trial test, AT5 - theoretical calculation. ANOVA with repeated measures at the level of statistical significance of  $p < 0.05$  was used to compare HR and power in the different methods. The mean  $\pm$  values of HR and power output AT were AT1 ( $156 \pm 11$  beat.min<sup>-1</sup>,  $233 \pm 27$  W) AT2 ( $157 \pm 6$  beat.min<sup>-1</sup>,  $235 \pm 27$  W), AT3 ( $173 \pm 14$  beat.min<sup>-1</sup>,  $313 \pm 75$  W), AT4 ( $162 \pm 11$  beat.min<sup>-1</sup>,  $234 \pm 27$  W) and AT5 ( $165 \pm 7$  beat.min<sup>-1</sup>). We found statistically significant differences between both compared values ( $p = 0.000$ ). By pairwise comparison were found significant differences between AT3 and AT2 ( $p = 0.037$ ) as well as between AT2 and AT5 ( $p = 0.039$ ) at HR values. At power output values significant differences were found by pairwise comparison between AT3 and AT4 ( $p = 0.039$ ), AT3 and AT2 ( $p = 0.013$ ), AT3 and AT1 ( $p = 0.039$ ). AT3 method couldn't be used with good accuracy, conversely a noninvasive field test AT4 meets the requirements for practical needs by coaches and athletes.

**UNIQUE ACTIVATION OF THE QUADRICEPS FEMORIS DURING MULTI-JOINT EXERCISE: IMPLICATION FOR TRAINING-SPECIFICITY OF INDIVIDUAL MUSCLES**

Ema, R., Kawakami, Y.

*Waseda University*

Introduction Activation of the biarticular rectus femoris is lower than the monoarticular vasti (lateralis, medialis, and intermedius) during leg extension exercise (simultaneous extensions of knee and hip joints) (Ploutz-Snyder et al. 1995). This fact may underlie the lack of rectus femoris hypertrophy by leg extension training that causes significant hypertrophy of the vasti (Ema et al. 2014). However, previous studies did not provide detailed data of the magnitude of difference in activation among the muscles, and there is shortage of knowledge as to why inter-muscular differences exist in hypertrophic responses. Our recent data (Ema et al. 2014) also suggest inter-muscle differences in muscle activations over fatiguing contractions during repetitive leg extension exercises. This study examined this possibility. Methods Fifteen healthy men performed knee extension and leg press exercises at an intensity of 20, 40, 60 and 80% of one repetition maximum (1RM) load (experiment 1). In the experiment 2, 14 healthy men conducted leg press at 40 and 80% of 1RM load until exhaustion. Muscle activation during the exercises was measured for the vastus lateralis, vastus medialis and rectus femoris by using surface electromyography and root mean square (RMS-EMG) values were determined. Results and Discussion In the experiment 1, there were no differences in RMS-EMGs of the vastus lateralis and vastus medialis between knee extension and leg press at any intensities. The RMS-EMG of the rectus femoris was significantly higher during knee extension than leg press. In addition, there was no statistical difference in RMS-EMG of the rectus femoris between leg press at 80% of 1RM load and knee extension at 20% of 1RM load. The results of experiment 2 showed significant increases in RMS-EMGs of the vastus lateralis and vastus medialis in both intensities. The RMS-EMG of the rectus femoris did not change at 80% but increased at 40% of 1RM load, although at the point of muscular failure at 40% of 1RM load rectus femoris RMS-EMG was only 24% of the 1RM knee extension. The results show that muscle activation of the biarticular rectus femoris is substantially low and does not increase following fatiguing leg extension exercise even at high intensity, unlike the monoarticular vasti. These may be related to the significant hypertrophy of the vasti but not of the rectus femoris following chronic leg extension exercise (Ema et al. 2014). References Ema R, Wakahara T, Yanaka T, Konda S, Kanehisa H, Kawakami Y. (2014). 19th annual Congress of the European College of Sport Science. Ploutz-Snyder LL, Convertino VA, Dudley GA. (1995). *Am J Physiol*, 269, R536-43. Contact ryoichi.3179@ruri.waseda.jp

**MUSCLE SYNERGIES OF LOWER LIMBS DURING VERTICAL JUMP**

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Introduction In human vertical jump, multiple muscles are activated in a timely way and in a moment, in order to generate hip joint torque and knee joint torque ankle joint torque. Hence, very complicated and precise control is required in human vertical jump. In the study of motor control, muscle synergy, neural control mechanism activating multiple muscles coordinately was suggested (Tresch et al., 1999; Ting and Macpherson, 2005; d'Avella et al., 2003). Human vertical jump may be low-dimensionally achieved by muscle synergies. Therefore, the purpose of this study is to clarify how the CNS control human vertical jump based on muscle synergy. Methods Subjects performed different types of maximum jump, i.e., squat and countermovement jumps with and without arms swing. There were 5 trials with a sufficient rest for removing fatigue between each type of jump. During tasks, the vertical and horizontal ground reaction forces, the three-dimensional position coordinate of locations of the 29 anatomical landmarks and electromyogram (EMGs) of 24 muscles in right side were measured. The EMGs were divided by standard deviation of each muscle and were combined into matrix. The nonnegative matrix factorization was applied to extract individual muscle synergies and their activation coefficients of muscle synergies (Lee and Seung, 1999; Tresch et al., 1999). Results Muscle synergies and their activation coefficients were extracted from all subjects for each task. In countermovement jump, the peaks of activation coefficients come at the similar timing and rhythm for all subjects. Muscle weighting of synergies activated in the second phase from the last were similar for all subjects ( $r = 0.42 - 0.74$ ). Muscle synergies in other phases were differ among subjects, but there are similar synergies activated in different timing. Discussion The significance finding was that 4 or 5 muscle synergies were extracted from EMGs of 24 muscles in countermovement jump to sufficiently reconstruct the original EMG. That suggests that human vertical jump is low-dimensionally achieved by muscle synergies. The peaks of activation coefficients occur at the similar timing and rhythm for all subjects, while muscle synergies activated in the same timing were differ among subjects. In human jump, the CNS inherently utilizes similar muscle synergies and timing of activation of muscle synergies has similarity, but how order the CNS activates the muscle synergies are different among individuals. References d'Avella A, Saltiel P, Bizzi E. (2003). *Nat Neurosci* 6, 300-308. Lee DD, Seung HS. (1991). *Nature* 401, 788-791. Ting LH, Macpherson JM. (2005). *J Neurophysiol* 93, 609-613. Tresch MC Saltiel P, Bizzi E. (1999). *Nat Neurosci*, 162-167. Contact Hirootakagi030402@gmail.com



## Mini-Orals

### MO-PM35 Training and Testing: Strength

#### TRAINING OUTPUT MONITORING SCALE IN SOCCER

Muñoz-Lopez, A., Naranjo Orellana, J., De la Cruz Torres, B.

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**Introduction** Although some subjective (1, 2) and objective (3) methods have been proposed to quantify training loads in soccer, there is still a lack on the calculations to obtain estimated training loads values. The purpose of this study was to validate a new method to monitor the training output in soccer (TOM Scale). **Methods** 26 male professional football players from the same National European Association team participated on this study. External load variables (ELV) (total distance (TD), accelerations (ACC), decelerations (DCC), sprints, impacts, impacts over 7G and work-rest ratio) with a multiple sensor device (Wimu, Realtrack Systems, Spain) and internal load variables (ILV) (relative heart rate (HR), time spent on different HR zones, Edwards and Banister TRIMPS) with a HR monitor (GARMIN HRM, Garmin, USA) were recorded from 22 training sessions and 2 friendly official matches for each player. The Borg Scale 6-20 was modified following the lactate curve in order to fit an exponential curve of the values used to estimate the session loads. Session loads were calculated multiplying the new subjective estimated values by the effective volume of each session (TOM Scale). The Session-RPE was also used for each session. Correlation analysis assessed the relationships between TOM Scale and Session-RPE with ELV and ILV. Multiple linear regression analysis was also performed to find the fitness measures that better explained the new scale. Results Large to nearly perfect significant correlations ( $p < 0.001$ ) were found between TOM Scale and all the ELV. These correlations were higher in all variables comparing with Session-RPE, although smaller for ACC and DCC. Moderate to nearly perfect correlations ( $p < 0.001$ ) were also found between TOM Scale and all the ILV. With ILV, Session-RPE only correlated with Edwards and Banister TRIMPS with the same strength (nearly perfect). Multiple lineal regression revealed that TD, DCC, sprints and impacts over 7G were the variables that better explained the new loads ( $r = 0.976$ ). **Conclusion** Understanding the load as an exponential curve (TOM Scale) results in a better method than a linear load increment (Session-RPE) to quantify training and match play loads in soccer. **References** 1. Impellizzeri, F. M., Rampinini, E., Sassi, A., & Marcora, S. M. (2004). Use of RPE-Based Training Load in Soccer, 36(6), 1042–1047. 3. 2. Rebelo, A., Brito, J., Seabra, A., Oliveira, J., Drust, B., & Krstrup, P. (2012). A New Tool to Measure Training Load in Soccer Training and Match Play. *International Journal of Sports Medicine*, 33(04), 297–304. 3. Akubat, I., Barrett, S., & Abt, G. (2013). Integrating the Internal and External Training Load in Soccer. *International Journal of Sports Physiology and Performance*.

#### SPRINT KINETICS AND KINEMATICS ON A NON-MOTORISED TREADMILL ARE UNIQUE TO POSITION IN RUGBY ATHLETES

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**INTRODUCTION** Unique positional characteristics are an accepted part of rugby union. Ruling structures indirectly govern athletes to specific actions that result in distinct mechanical stresses specific to position. While variables such as horizontal force (FH) have been highlighted as fundamental to sprint performance in rugby (Cross et al., 2014), kinetics and kinematics specific to position have not been investigated. We assessed rugby athletes on a non-motorised treadmill (NMT) to illuminate if position-specific sprint profiles exist. **METHODS** Thirty male academy rugby athletes, separated into forwards and backs ( $n = 15/15$ ), performed maximal 6s sprints on a NMT. Comparison of kinetic and kinematic variables were made between positions during initial acceleration (steps 1-2), acceleration (steps 3-12) and maximal velocity (steps 13-22) phases using effect sizes (ES). **RESULTS** Backs produced higher absolute and relative FH at initial acceleration ( $ES = 1.07$  and  $ES = 1.6$  respectively) but lower absolute FH at acceleration ( $-0.78$ ) and maximal velocity ( $ES = -1.0$ ) compared to forwards. Backs displayed faster split times at 2m ( $ES = -1.03$ ), 5m ( $ES = -0.82$ ), 10m ( $ES = -0.63$ ) and 15m ( $ES = -0.50$ ) but achieved a lower peak velocity ( $ES = -0.54$ ) compared to forwards. **DISCUSSION** During NMT sprinting, backs generated greater levels of FH during initial acceleration, resulting in faster short-distance split times, whereas forwards produced greater levels of FH during acceleration and maximum velocity. While backs typically reach greater peak velocities during over-ground sprinting (Cross et al., 2014), forwards displayed higher peak velocities on the NMT; seeming contradictory to moderate correlations between NMT and over-ground sprinting (Highton et al., 2012). Given forwards are heavier and possess greater posterior-chain strength (Brown et al., 2014), the superior levels of absolute force and peak velocities exhibited by this position supports the notion that NMT sprinting favours these characteristics. The high intrinsic resistance of the NMT, requiring greater levels of FH, reinforces the contention that the lighter and weaker backs were disadvantaged in maintaining faster split times with increasing distance and reaching peak velocity. The relationship between over-ground and NMT sprint performance may be weakened in sporting codes featuring position-subsets with differing mechanical profiles. Practitioners wishing to profile and compare sprint mechanics using NMTs are advised to separate athletes by position. **REFERENCES** Brown SR, Brughelli M, Griffiths PC, Cronin JB. (2014). *Int J Sports Physiol Perform*, 9(2), 358-361. Cross MR, Brughelli M, Brown SR, Samozino P, Gill ND, Cronin JB, Morin J-B. (2014). *Int J Sports Physiol Perform*, in press. Highton JM, Lamb KL, Twist C, Nicholas C. (2012). *J Strength Cond Res*, 26(2), 458-465.

#### MONITORING OF TRAINING LOAD AND FATIGUE IN YOUTH CYCLISTS

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**Introduction** The physiological responses of athletes are basically due to the training stimulus during different training phases. Especially during periods of high training load, as in training camps, there is an increased risk of overreaching (Meeusen et al. 2013). Several markers were suggested to monitor training load, however, data on stress reactions in children and youth are rare. Therefore, the aim of the present study was to investigate the stress reactions and fatigue using minimally invasive "point-of-care-testing" (POCT) devices and other non-invasive parameters in youth cyclists to high loads of endurance training. **Methods** Six well-trained youth male cyclists (age:  $15.0 \pm 1.3$  years; height:  $177.2 \pm 8.8$  cm; weight:  $58.5 \pm 6.9$  kg; relative  $VO_{2peak}$ :  $59.7 \pm 7.0$  mL/kg/min) performed a 7-day pre-season training camp (517 km, 5820 m of altitude difference). The cycling training consisted of two training blocks, each lasting three days, separated by one day of recovery. During the camp a set of biomarkers (albumin, bilirubin, creatine kinase (CK), urea, aspartate aminotransferase

(AST), alanine aminotransferase (ALT)) and non-invasive parameters (person's perceived physical state (PEPS), resting heart rate, heart rate variability, questionnaires on muscle soreness (visual analog scale, VAS)) were collected every morning. Two days before and after the training camp, subjects performed an incremental step test and a Wingate anaerobic test to determine performance/fatigue. Results Performance did not change significantly. Albumin significantly decreased in the second training block. Bilirubin significantly increased in the first training block. CK and urea were significantly increased over both training blocks. VAS significantly increased only at recovery days. No significant changes were observed for AST and ALT. Perceived physical energy and health significantly decreased in the second training block. Perceived physical fitness and flexibility did not change over time. Resting heart rate and measures of heart rate variability (meanRR, RMSSD, SDNN) did not change significantly over time. Discussion Both, the blood parameters as well as the non-invasive markers showed a load-dependent rise or fall during the 7-day training camp, respectively. However, performance was not impaired despite the high training load. Since no single marker can be used as an indicator of the training stress of an athlete, a specific monitoring from a combination of performance tests, physiological, biochemical, immunological and psychological variables, especially in periods of high training loads, might be the best strategy to determine the athletes strain. The minimal invasive character of POCT might be one way to establish biochemical, besides psychological, monitoring also in elite youth athletes. References Meeusen, R. et al. (2013). *Med Sci Sports Exerc*, 14 (1), 186–205 Contact y.kilian@dshs-koeln.de

### **INCREASED HAIR CORTISOL LEVELS IN FEMALE ENDURANCE ATHLETES THROUGH ALTITUDE TRAINING: A USEFUL DIAGNOSTIC TOOL FOR OVERTRAINING**

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**Introduction** Altitude training (AT) effectively enhances endurance performance, probably due to a positive adaptation to chronic stress caused by hypobaric-hypoxia; however, the chronic stress of excessive training without sufficient rest can lead to the physical and psychological impairment of ability called overtraining. Therefore, monitoring chronic stress is necessary for assessing the success or failure of AT. However, a diagnostic tool that monitors chronic stress has yet to be developed. Recently, hair cortisol has been increasingly gaining attention as a novel biomarker of chronic stress (Davenport et al., 2006), and our laboratory previously found that higher hair cortisol levels are related to lower POMS scores for vigor, which is an overtraining symptom among long-distance runners (Soya et al., 2013). Therefore, we hypothesized that hair cortisol levels increase after AT and that elevated hair cortisol might be associated with training effects. To test this, we monitored longitudinal cortisol levels in hair together with several physiological parameters related to endurance capacity in female endurance athletes during and after one-month AT at an altitude of 1,800 m. **Methods** Seven female long-distance runners (age:  $20 \pm 3.8$  years, height:  $159 \pm 4.2$  cm, weight:  $47 \pm 1.2$  kg) trained at an altitude of 1,800 m for one month in Albuquerque, USA. Before and after the AT, cortisol levels in hair, blood and urine, and total blood volume, total hemoglobin mass (THb), red blood cell volume (RCV) at rest together with VO<sub>2</sub>max on the treadmill were measured. Hair cortisol was methanol extracted and measured in the most proximal 1 cm of hair by ELISA. Results VO<sub>2</sub>max was significantly increased after AT. However, RCV and THb together with total blood volume did not change. Hair cortisol, but not blood and urine cortisol, was significantly increased after AT, and was negatively correlated with  $\Delta$ THb and  $\Delta$ RCV. **Discussion** In this study, most athletes had increased VO<sub>2</sub>max post-training, but did not have any endurance parameters, such as increased THb and total blood volume that would imply positive endurance capacity. Indeed, we found for the first time that while blood and urine cortisol levels did not increase, hair cortisol levels did increase after AT, and the hair cortisol levels accumulated during AT had a negative correlation with changes in THb and RCV levels among the endurance parameters. Thus, the higher chronic stress of AT may reach the ceiling by depressing production of these parameters. These findings suggest that hair cortisol could be a useful biomarker of chronic stress caused by AT, which may in turn be a diagnostic tool for detecting overtraining.

### **BILATERAL SQUAT SYMMETRY PRE AND POST A 7 WEEK TRAINING PROGRAM FOR SURFING ATHLETES**

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**Introduction** Surfing involves asymmetrical positions, which may cause bilateral differences among competitive surfing athletes. Previous studies have found that an imbalance of approximately 6% exists in the ground reaction force among college athletes' squat pattern (Newton et al., 2006). Furthermore, it has been reported that bilateral squat asymmetry can be corrected using feedback systems (McGough et al., 2010). The purpose of this study investigated whether a seven-week training program incorporating strength and gymnastics could decrease the asymmetry between the left and right side. **Methods** Seven junior competitive surfing athletes (6 males and 1 female) participated in the study (age:  $16.4 \pm 0.67$  y, weight:  $67.3 \pm 7.7$  kg, height:  $1.74 \pm 0.06$  m) and were tested pre- and post-training on symmetry during bilateral squats. Using a split stance between two force plates (Fitness Technology, Adelaide) recording at 600 Hz, the athletes performed 10 repetitions, first without any external load (BW) and secondly with an external load (EL) corresponding to 25% of their BW. From the average force of the left and right side of the six mid repetitions, symmetry index (SI) was calculated (McGough et al., 2010). The seven-week training program consisted of two sessions per week of gymnastics and lower body strength exercises. Paired non-parametric statistical tests (Wilcoxon) were used to evaluate differences from pre- to post-training, with significance criteria set at  $p < 0.05$ , and effect size  $r > 0.5$  considered large. Results A decrease in SI was found for the BW bilateral squat task ( $p = 0.01$ ,  $r = 0.59$ ), however not for the EL bilateral squat task ( $p = 0.15$ ,  $r = 0.19$ ). The mean pre- to post-training SI for the BW squat changed from  $8.3 \pm 11.1$  to  $4.2 \pm 5.2$ , and from  $7.8 \pm 8.2$  to  $6.3 \pm 7.4$  for the EL squat, with a large individual variation. **Discussion** Although the number of athletes that participated in this study was low, there seems to be a trend showing that asymmetry can be reduced with lower body strength and gymnastics training in seven weeks. The role of a symmetrical squatting pattern for surfing athletes remains unknown, and should be investigated further. Previous studies have proposed that there may be a relation between lower extremity asymmetry and injury risk for athletes (Brumitt et al., 2013), which stresses the need to implement a bilateral screening tool and lower body strength program for athletes. References Newton RU et al. (2006). *J Strength Cond Res*, 20(4), 971-977. McGough, R, Paterson K, Bradshaw EJ, Bryant AL, Clark RA (2010). *J Strength Cond Res*, 26(1), 47-52. Brumitt J. et al. (2013). *Int J Sports Phys Ther* 8(3), 216-227. Contact lina@surfingaustralia.com

### ELBOW ANGLE CHANGES DURING THE UNDERWATER STROKE PHASE IN SPRINT-ASSISTED TRAINING FOR COMPETITIVE SWIMMERS

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**Introduction:** As the outcome of a swimming race is decided by only a fraction of a second, many different training methods have been developed to improve performance. One such training method is sprint-assisted training, which is commonly used by coaches and competitive swimmers to improve the swimmer's ability to apply force over a greater distance. However, the most appropriate assist velocity is unknown. **Purpose:** To investigate the effects of changes in the assist velocity on freestyle swimmers' form, with a focus on their elbow movement during the underwater stroke phase. **Methods:** This study evaluated 7 male Japanese competitive collegiate swimmers. A pulling assist system with a velocity meter (Maglischo, 2003), which includes a wire line to pull the subjects, was used. This system precisely recorded the intracyclic velocity variations during 25 m of maximum effort freestyle swimming, with assist velocities of 0 m/sec (baseline), 2.0 m/sec, 2.2 m/sec, and 2.4 m/sec, respectively. In addition, an underwater video analysis system was used to monitor the subjects' elbow movements from in front of the subjects. Using the video data, the elbow angles (degrees of elbow flexion at end of the first half during underwater stroke phase) were determined for each subject. **Results:** The mean  $\pm$  standard deviation of the elbow angles for the 7 subjects was  $130.0 \pm 14.8$  degrees at baseline. The changes in the elbow angles at 2.0 m/sec, 2.2 m/sec, and 2.4 m/sec (vs. baseline) were  $6.0 \pm 4.1$  degrees,  $7.4 \pm 6.1$  degrees, and  $14.0 \pm 4.6$  degrees, respectively (Jonckheere-Terpstra test,  $P = 0.006$ ). Thus, the incremental changes in the elbow angles (relative to baseline) became larger as the mean assist velocity increased. **Conclusion:** Underwater stroke pattern was changed by incremental increases in the assist velocity, and this finding may help in developing optimum assist conditions for training competitive swimmers. **Reference:** Maglischo, E. W. (2003) *Swimming Fastest*. Human Kinetics.

### EFFECTS OF 8 WEEKS OF ISOKINETIC TRAINING ON POWER, GOLF KINEMATICS, AND CLUB HEAD SPEED IN ELITE GOLFERS

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**Introduction:** Elite competitive golfers commonly use physical conditioning as a way of improving playing results. Multiple studies have investigated the use of different training methods for improving performance but few studies have investigated the use of isokinetic power training as a way of improving swing kinematics and/or club head speed (CHS). The specific objective of the study was to investigate if eight weeks of isokinetic power training was more effective than traditional power training in improving swing kinematics and CHS. **Methods:** 20 competitive elite golfers (handicap better than -3.1), 13 men and 7 women, (age  $22 \pm 2$  years) were tested for lower body power (countermovement jump and loaded vertical squat jump 20,40 & 60kg), rotational power (seated upper body rotational power at 10% of body weight; bw) and golf swing kinematics (pelvis, thorax and lead arm peak rotational velocities using electromagnetic motion capture system; Polhemus Inc. USA ) and club head speed (doppler-radar launch monitor system; FlightScope, South Africa). Participants were split into a control (CTL) group ( $n=10$ ) who continued with the regular strength and power training and an intervention (IK) group ( $n=10$ ) performing isokinetic power training in the isokinetic 1080Quantum system (1080Motion, Sweden) during 8 weeks. The intervention focused on barbell squat (22kg at 0.5 ms<sup>-1</sup>) and standing rotation (10% body weight at 1 ms<sup>-1</sup>). **Statistical analysis:** a 2 (between; groups) x 2 (within; time) ANOVA assessed any differences in power, club and swing kinematics. **Results:** Statistically significant improvements were observed in both the IK and CTL group for rotational power ( $p < 0.001$ ), CHS ( $p = 0.025$ ), and peak arm speed ( $p = 0.001$ ). There were no significant differences in countermovement jump height, peak power during squats, peak pelvis speed, or peak thorax speed following the intervention period. **Discussion:** After 8 weeks of power training, both rotational power and peak arm speed improved as did the performance measure of CHS in both the IK and CTL group. However no significant changes were found between the two groups. **In conclusion,** there was no evidence suggesting that isokinetic training, as performed in this study, is neither detrimental, nor more effective, than traditional strength training when it comes to increasing CHS in golf performance.

### THE EFFECTS OF 8 WEEKS OF PLYOMETRIC TRAINING ON SPRINT AND JUMP PERFORMANCE IN FEMALE HIGH SCHOOL BASKETBALL PLAYERS

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*milan*

**Do not insert authors here Aim:** Many studies of match-analysis have recorded a great number of jumps, sprints and change of direction during a basketball competitions (Ben Abdelkrim et al., 2007; McInnes et al., 1995). Although these high intensity activities represent a small portion of the total game time, causing 42% of the energy expenditure, they are believed to be very important for the result of a match. The aim of this study is evaluate the influence of plyometric program on sprint and jump performance in female basketball players. **Methods:** Twenty-four young female basketball players ( $15.9 \pm 0.8$  y-o;  $170.7 \pm 7$  cm;  $61.5 \pm 8.2$  kg) were involved in a 8-wks protocol consisting of 2 session/week with 6/7 exercises in accordance with NSCA plyometric guideline. All subjects were divided in two groups: 12 in a Training Group (TG) and 12 in a Control Group (CG) that performed the normal training routine of technical basketball drills. Subjects were tested at baseline (BL) and at week 8 (W8). Vertical jump performance (height) was measured by using the Optojump system (Microgate, Italy) and sprint over 20 meters was measured using Polifemo Photocell system (Microgate, Italy). **Results:** All participants completed the 8 weeks program. A paired T-test and a unpaired T-test were used respectively to assess pre-post differences within groups and between groups. Results were expressed as mean  $\pm$  SD. Significant differences were found at  $p < 0.05$ . The experimental group at W8 showed significant improvements in vertical jump height for both CMJ test and Stiffness test, whereas no significant result were founded in sprint performance (ES 0.2). The control group did not show any significant difference at W8 compared to BL. No significant difference between groups with unpaired T-test although very positive effect sizes for all variables in post-training differences. **Conclusion:** The study shows how a simple and short program of plyometric exercises has a significant influence on the vertical jump height in young female basketball players. **References:** Ben Abdelkrim et al. (2007) *Br J Sports Med*; Vol. 41 - Issue 2: 69-75. McInnes et al. (1995) *J Sport Sci*; Vol. 13 - Issue 5:387-97 Contact roberto.benis@unimi.it

### EFFECTIVENESS OF 4-WEEK LOADED MOVEMENT OR BODYWEIGHT TRAINING IN IMPROVING THE THICKNESSES OF THE DEEP AND SUPERFICIAL ABDOMINAL MUSCLES IN COLLEGIATE STUDENTS

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**Introduction:** Loaded movement training (LMT) is defined as a multidirectional, task-oriented resistance exercise in which external resistance is applied to the body. LMT is performed widely in the United States and Japan for functional training. LMT may improve body composition, increase energy expenditure, muscle strength, and motor function. However, evidence from direct scientific research to support these claims is lacking. The purpose of this study was to investigate the effects of the thicknesses of the deep and superficial abdominal muscles, muscle endurance, and muscle power on 4-week LMT or body weight training (BWT). **Methods:** Nineteen collegiate students (age,  $20.5 \pm 0.7$  years; height,  $164.3 \pm 9.1$  cm; body mass,  $56.0 \pm 8.3$  kg) were allocated randomly into either a LMT or a BWT group. Baseline testing involved a 30-sec sit-up test (number of times) of muscle endurance, 10-sec incremental bike test of peak power, impedance measurements of body weight and body fat rate, and measurements of abdominal circumference and thicknesses of the deep and superficial abdominal muscles. The thicknesses of the rectus abdominis, external oblique, internal oblique, and transversus abdominis muscles were measured on ultrasonographic images. After baseline testing, the participants were allocated between the LMT and BWT intervention groups, which they performed 12 times over 4 weeks ( $3 \times 4$  weeks). The subjects performed 15 min of intermittent training (20-s work, 10-s rest) per session. The LMT group used a 4-kg ViPR weight in every training session. A rating of perceived exertion (RPE) was used to evaluate the intensity of the LMT and BWT in each session. **Results:** RPE did not differ between the two groups. The impedance measurements of body weight and body fat rate did not differ between before and after the intervention in both groups. LMT significantly decreased abdominal circumference (before vs. after the intervention:  $73.1 \pm 6.5$  vs.  $70.7 \pm 6.4$  cm,  $p < 0.05$ ), and the transversus abdominis thickness significantly increased in LMT ( $0.57 \pm 0.13$  vs.  $0.73 \pm 0.12$  cm,  $p < 0.01$ ). BWT significantly increased the 30-s sit-up test score ( $30.8 \pm 4.3$  vs.  $32.5 \pm 4.5$  times,  $p < 0.001$ ) and peak power ( $586.7 \pm 153.9$  vs.  $621.5 \pm 178.3$  W,  $p < 0.05$ ). The rectus abdominis thickness significantly increased in BWT ( $1.08 \pm 0.29$  vs.  $1.15 \pm 0.25$  cm,  $p < 0.05$ ). **Discussion:** Results demonstrated that LMT using the 4-kg ViPR weight improved the thickness of the deep abdominal muscles (transversus abdominis) and decreased abdominal circumference. BWT improved the thickness of the superficial abdominal muscles (rectus abdominis), and muscle endurance and peak power. Therefore, LMT can improve body composition. **References:** Yamashita N, Ito R, Nakano M, Matsumoto T. (2015). JSCR, 29(1), 116–125. Ota M, Ikezoe T, Kaneoka K, Ichihashi N. (2012). Arch Gerontol Geriatr, 55, e26–e30. Akca F, Aras D. (2015). JSCR, Post Acceptance: February 3. McCall, P. (2014). Sign, 888, 825–3636. Contact: s-izumi@hosei.ac.jp

### ACUTE EFFECTS OF ONE-LEGGED STRETCHING ON REGIONAL ARTERIAL STIFFNESS IN HEALTHY YOUNG MEN

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**BACKGROUND:** Acute aerobic exercise induces decrease in arterial stiffness, and chronic aerobic exercise training also reduces arterial stiffness. Additionally, recent studies reported that chronic stretching exercise reduced blood pressure and improved arterial function (Cortez-Cooper MY, et al., 2008, Wong A and Figueroa A., 2014). However, the effect of arterial stiffness on acute stretching exercise remains unclear. We hypothesized that arterial stiffness was transiently reduced in stretched region. **PURPOSE:** The purpose of this study was to clarify whether regional arterial stiffness was reduced by acute passive one-legged calf stretching in healthy young adults. **METHODS:** Fourteen healthy young men ( $21 \pm 1$  years,  $172 \pm 2$  cm,  $65 \pm 2$  kg) volunteered for the study. Subjects were performed passive one-legged calf stretching exercise (6 repetitions of 30 seconds with a 10-second recovery). Femoral-ankle (faPWV), as an index of arterial stiffness, and systolic blood pressure (SBP) and diastolic blood pressure (DBP) in both lower legs were measured before and immediately after and 15, 30 min after stretching exercise. Carotid-femoral pulse wave velocity (cfPWV) as an index of central arterial stiffness and heart rate (HR) were also measured. **RESULTS:** faPWV in the stretched leg was decreased immediately ( $p < 0.01$ ) and 15 min ( $p < 0.05$ ) after passive stretching exercise compared with before stretching exercise. This acute reduction of faPWV was returned to the basal levels at 30 min after stretching exercise. On the contrary, faPWV in the unstretched control leg was not changed by stretching exercise. Additionally, the passive one-legged stretching exercise did not alter SBP and DBP in both legs, and cfPWV and HR was not changed by stretching exercise. **CONCLUSION:** These results suggest that regional arterial stiffness in the stretching leg was reduced by acute passive one-legged calf stretching in healthy young adults. Supported by Grants-in-Aid for Scientific Research (#23680071 and #25560378, M. Iemitsu). **References:** Cortez-Cooper MY, et al. (2008). Eur J Cardiovasc Prev Rehabil 15: 149-155. Wong A, Figueroa A. (2014). J Hum Hypertens 28: 246-50. Contact y-yamato@pt-u.aino.ac.jp

## Mini-Orals

### MO-PM38 Training and Testing: Team Sports I

#### RELATIONSHIP BETWEEN HEIGHT, BODY MASS AND RUNNING SPEED PERFORMANCES IN YOUTH MALE SOCCER PLAYERS

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Do not insert authors here **Introduction** In adolescence, different growth- and maturity-related factors influence running speed, and body mass and height have found to be determinants of the performances. In youth male soccer, the knowledge of performance related to chronological age, especially around the growth spurt is important, because physically taller and heavier player, tend to be selected. The aim of the current study was to investigate the relationship between anthropometric (height / body mass), and running speed and agility. **Methods** In total, 132 young male soccer players, aged 10-16 years, were tested (Brower Timing System) in straight-line speed, 20-m with 10-m split time, and in agility performance. The participants were divided in three age groups; 10-11 (mean  $10.8 \pm 0.50$ ) years, 13-14 (mean  $13.9 \pm 0.50$ ) years and 15-16 (mean  $15.5 \pm 0.24$ ) years. Relationship between anthropometrics (height and body mass) and results of speed and agility performance were determined using Pearson correlation (r) analyses. Two way ANOVA was used to test between subject effects. **Results** Body mass was correlated with 10-m ( $r = 0.40$ ,  $p < 0.05$ ), and 20-m ( $r = 0.33$ ,  $p < 0.05$ ) straight-line sprint in the

13-14 year-old group, and in 20-m ( $r = 0.34$ ,  $p < 0.05$ ) and 10 to 20-m ( $r = 0.35$ ,  $p < 0.05$ ) straight-line speed in the 15-16-year-old group. Body height was correlated with 20-m sprint ( $r = 0.55$ ,  $p < 0.01$ ), 10 to 20-m sprint ( $r = 0.53$ ,  $p < 0.01$ ), in the 13-14-year-old group, and in 20-m sprint ( $r = 0.42$ ,  $p < 0.01$ ), and 10 to 20-m sprint ( $r = 0.48$ ,  $p < 0.01$ ) in the 15-16-year-old group. Agility correlated only with body height in the 13-14-year-old group. ( $r = 0.32$ ,  $p < 0.05$ ). In 10-11-year-old age, there was no significant relationship between anthropometrics and speed and agility performance. Discussion This study has demonstrated that body height and body mass influence straight-line sprint up to 20-m, in 13 to 16 year-old male soccer players. In this age group, taller and heavier participants was better in straight-line speed, however, in the 10-11 year-old group there was no significant relationship. The result is attributable to their maturation status, with huge difference in height and body mass following the growth spurt. However, the agility performance was significant better for the taller and heavier participants only in the 13-14 year old group. Selecting based on anthropometry (height and body mass), leads to advantage for taller and heavier players, and may lead to selection bias and drop-outs in youth soccer. References Oliver JL, Lloyd RS, Rumpf MC. (2013). Developing speed throughout childhood and adolescence. The role of growth, maturation and training. *J Strength Cond Res*, 35(3), 42-48. Wong PL, Chamari K, Dellal A, Wisløff U. (2009). Relationship between anthropometric and physiological characteristics in youth soccer players. *J Strength Cond Res*, 23(4), 657-667

## DEVELOPMENT AND RELIABILITY OF THE COLORADO COLLEGE ANAEROBIC CAPACITY TEST

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Field based sports such as football (soccer) involve repeated high intensity, short duration sprints which rely on a high rate of cellular ATP production, ability to recover quickly, and a large anaerobic capacity to do work. Various field tests are used by coaches to assess anaerobic fitness; however, many tests are pass/no-pass and do not provide a graded level of anaerobic capacity, or involve sprints that are much longer than are found in game situations. Therefore, the purpose of this study was to develop a field test for anaerobic capacity that would be easy to administer, provide reliable results with field-based athletes, and provide coaches with useful information about athletes' anaerobic fitness. The Colorado College Anaerobic Capacity Test (CAT) was developed after multiple testing sessions of various protocols with local field-based athletes serving as participants. In its final version the CAT consists of repeated 40 meter sprints (the width of the penalty area on a standard NCAA soccer field, 40.23-m/44-yds) at maximal speed. Athletes have 7 second to sprint the 40 meters, with 13 seconds of active recovery in between sprints. Athletes continue sprints back and forth every 20 seconds until they can no longer cover the 40 meters in 7 seconds, and their number of attempted sprints is recorded. The Colorado College Women's soccer team (NCAA D-I) performed the CAT twice within a 7-day period to evaluate the test's reliability, with 14 athletes completing both trials. The mean (SD) number of sprints attempted by the athletes in the two CAT trials was 8.0 (2.8) and 7.14 (3.0), respectively. A dependent t-test revealed that there was a significant difference ( $p=0.012$ ) between the number of sprints completed in the two trials, indicating that this test was not reliable. However, this poor reliability may be due to the fact that the soccer team had a practice on the morning that the second test was administered, but not the first. This unexpected practice may have affected the results in the second trial because the athletes were fatigued from a high-intensity practice. Continued testing is planned to evaluate the reliability and validity of the CAT with more subjects and with greater control over the amount of exercise done 24 hours prior to administering the test. Additional results may be available for presentation at the congress.

## VALUATION OF FOOTBALL PLAYERS LEVEL BY LOWER LIMBS STRENGTH USING CMJ 2.1

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Introduction The football players (FP) need high level of lower limbs strength during matches such as during headshots (Reilly and Korkusuz, 2008). Testing the vertical jump height is widely used to determine the lower limbs strength. The aim of this study was to determine if the new functional test Countermovement Jump 2.1 (CMJ2.1) (Alberti et al., 2015) was able to characterize the level of athletes. Methods 49 FP (age:  $21.0 \pm 7.0$  yrs; height:  $178.1 \pm 6.0$  cm; weight:  $73.6 \pm 5.3$  kg) were recruited from local high and low level football teams (HL:  $n=26$  and LL:  $n=23$ , respectively). The participants were tested on bipodalic countermovement jump height landing on two legs (CMJbip), landing on right leg (CMJ2.1R) and landing on left one (CMJ2.1L). The FP were also tested on right and left monopodalic countermovement jump height (CMJR and CMJL, respectively). In accordance to Shapiro-Wilks' normality test, Unpaired t-test or Mann-Whitney U test and Paired t-test or Wilcoxon test were performed using Aabel (versione 3.0.3; Gigawiz Ltd. Co., Tulsa, OK, USA). A p value lower than 0.05 was considered statistically significant. Results No statistical difference was detected in CMJbip between HL and LL ( $38.2 \pm 5.4$  cm and  $35.9 \pm 4.7$  cm, respectively). However, statistical differences were detected in CMJR ( $p < 0.001$ ) and CMJL ( $p < 0.001$ ) between HL and LL. Furthermore, a statistical difference was found in CMJ2.1R ( $p < 0.05$ : HL:  $33.5 \pm 5.5$  cm; LL:  $30.4 \pm 4.2$  cm), but no statistical difference was found in CMJ2.1L (HL:  $33.3 \pm 4.9$  cm; LL:  $31.1 \pm 4.4$  cm). In both groups, no statistical differences were detected between CMJ2.1R and CMJ2.1L. Greater statistical differences between CMJbip and CMJ2.1 were found in LL (CMJbip vs CMJ2.1R =  $p < 0.001$ ; CMJbip vs CMJ2.1L =  $p < 0.001$ ) than in HL (CMJbip vs CMJ2.1R =  $p < 0.01$ ; CMJbip vs CMJ2.1L =  $p < 0.01$ ). Discussion No statistical difference found in CMJbip between HL and LL could be explain by lower contribution of coordination skill and unspecific dynamic sport movement during this test as compared to monopodalic CMJ test. Indeed, the HL FP reached higher CMJR and CMJL than LL because of different strength level performed using one leg. Lower values recorded during CMJ2.1 as compared to CMJbip are due to unconsciously neuromuscular mechanism that permit to reduce the impact on the ground after jumps (Withrow et al., 2006). The differences detected in LL between CMJbip and CMJ2.1, in both right and left legs, are higher than HL. The smaller is the difference in vertical jump height between CMJ2.1 and CMJbip, the higher is the FP level. References Alberti G, Boccolini G, Rossi A (2015). XXIV edition of the International Conference on Sports Rehabilitation and Traumatology. London. Reilly T, Korkusuz F. (2008). New York: Routledge. Withrow TJ, Huston LJ, Wojtyls EM, Ashton-Miller JA. (2006). *Am J Sports Med*.

## FACTORS AFFECTING SLEEP BEHAVIOURS IN PROFESSIONAL AUSTRALIAN FOOTBALL PLAYERS

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Introduction Due to its physiological and psychological restorative effects, sleep is widely considered to be a critical component of recovery in high performance athletes (Fullagar et al., 2015). However, at present, relatively little is known about the moderating factors that influence sleep behaviours in elite team sport athletes (Lastella et al., 2015; Robey et al., 2015). The aims of this study were to investigate

the sleep/wake behaviour of professional Australian Football (AF) players, and examine the influence of training, playing level, the use of caffeine and technology on sleep/wake behaviours. Methods Twenty three professional AF players from the same professional club participated in this study. Sleep/wake behaviour was assessed using self-report sleep diaries and wrist actigraphy monitors for a minimum of 14 nights (range: 14-18) over a 21 day period during the competition season. Training dose, player wellness, caffeine intake, sleep location, technology use prior to sleep and playing level were also recorded. Results Players fell asleep at 22:57±1:06 h:min and slept for 530±91 min. Two players demonstrated signs of poor sleep. Whilst, there were no significant effects of training on sleep/wake behaviours, the number of awakenings, sleep efficiency, perceived sleep quality were reduced on the night prior to matches (all  $p < 0.05$ ) and time in bed, sleep time and perceived sleep quality were reduced on the night following matches (all  $p < 0.05$ ). Higher level players spent significantly less time in bed (~38 min) and time asleep (~30 min) than lower level players. Caffeine consumption during the day resulted in more awakenings and shorter sleep ( $d = 0.33$ ). Similarly, players who used technology prior to sleep spent less time in bed (~34 min), less time asleep (~31 min), although sleep quality was not affected. Perceived sleep quality showed moderate relationships with time in bed ( $r = 0.40$ ), sleep time ( $r = 0.33$ ) and number of awakenings ( $r = 0.30$ , all  $p < 0.05$ ). There were small relationships between self-reported soreness with sleep latency, efficiency, sleep time and number of awakenings ( $r = 0.20-0.36$ ). Discussion Whilst these data show that almost all players achieve adequate sleep, sleep/wake behaviours are reduced prior to, and following games. These perturbations in sleep around competition are likely due to increase anxiety, travel and social factors. The negative influence of caffeine and technology use prior to sleep provides empirical support to recent sleep hygiene suggestions to avoid caffeine/stimulant and technology immediately prior to going to bed. These data also provide some support to the construct validity of likert scale questionnaires as a non-invasive method for quantifying sleep in team sport athletes. References Fullagar, H., et al., (2015) *Sports Med*, 2015. 45: p.161-86. Lastella, M., et al., (2015) *Eur J Sport Sci*, 2015. 15: p.94-100. Robey, E., et al., (2014) *Eur J Sport Sci*, 2014. 14: p.410-7. Contact Aaron Coufts: Aaron.Coufts@uts.edu.au

### INTENSITY AND ENERGY EXPENDITURE OF EXERTIONS AND RATE OF PERCEIVED EXERTION AFTER FUTSAL TOURNAMENT MATCHES

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Introduction: Futsal is a very dynamic team sport. Futsal players perform similar moving actions like in outdoor football – sprints, running with high, medium and low intensity, gait, standing and specific actions with the ball – shooting, passing, tackling, heading, defending. Futsal players change the type of motion on average in every 3,38 [s] and the average time of sprint is 1,95 [s] separated with 80 [s] active resting periods (1). The substitutions are made during the match in order to give the players a possibility to reconstitute. The aim of the study was the assessment of the intensity, energy expenditure (EE) of the exertions and the rate of perceived exertion (RPE) during following matches of futsal tournament. Methods: Participants of the study were futsal players of the academic team. Heart Rate (HR) was registered during four following matches: 1st (A), 2nd (B), 3rd (C) and 4th (D). HR registration was continuous starting from the warm up of the players before the match and ending 5 minutes after the end of the match by Polar Team 2 system. Results: The highest intensity of exertion was observed in match A and equaled on average  $90,22 \pm 4,90$  %HRmax. Overall EE made by the players during four matches was on average  $395,11 \pm 118,70$  kcal/match. Average EE of single effort was  $16,33 \pm 5,36$  kcal/min. The highest EE was observed in match A – on average  $17,31 \pm 4,71$  kcal/min during single on the pitch period. It was value significantly higher comparing to three other matches. The RPE analysis did not show significant differences between matches, thus match C was characterized by the players as the most tiring (RPE  $15,1 \pm 1,52$ ). In matches A,B and D the average RPE was  $\leq 14 \pm 2,11$ . Discussion: The highest average intensity of effort was registered during the first match (A), it equaled  $90,22 \pm 4,90$  % HRmax which is higher than the value  $86,4 \pm 3,8$  % HR max observed in the first Brazilian league futsal players who participated in Rodriguez study (3). Intensity observed in our study is very high and what is more is considerably higher comparing to the intensity of 11-players football (2). In our study the EE values ranging from  $360,57 \pm 99,39$  to  $443,12 \pm 113,58$  [kcal/match] was considerably higher than in other official futsal matches with the value of  $313 \pm 9,3$  [kcal/match] observed by Rodriguez et al. (3). References: 1. Castanga C, et al. (2009). *Journal of Science and Medicine in Sport*, 12, 490-494. 2. Stølen T et al. (2005) *Sports Medicine*, 35(6), 501-36. 3. Rodrigues VM et al. (2011). *Journal of Strength and Conditioning*. 25 (9), 2482-7.

### YOUTH SOCCER PLAYERS WHO ENTER, CONTINUE AND -OUT A PROFESSIONAL YOUTH ACADEMY

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Acknowledgements This study was supported by grants from the Basque Government (BF12010-35 and IT700-13) INTRODUCTION Elite adolescent soccer players are often relatively homogeneous in training history, functional capacity and sport-specific skills. This homogeneity makes it even more difficult for training staff to evaluate which factors influence the progression of the young players. As such, the purpose of the present study was to identify the factors that determine player's potential to progress to higher levels within an elite youth soccer academy. METHODS The sample included 50 players ( $12,27 \pm 0,18$  years) of the professional soccer club Athletic Club (Spanish, La Liga). Data was collected at the beginning and at the end of a competitive-season, with new players joining the club at the beginning of the season (Enter players=EP), players progressing to the next age category within the club (Club players=CP) and players leaving the club at the end of the season (Drop-out players=DP). The following measurements were undertaken: complete anthropometry, velocity 15-m, Barrow's modified agility test, Yo-Yo intermittent recovery test level 1 (Yo-Yo IR1) and counter-movement jump test (CMJ). Also, chronological age and age at peak height velocity were calculated. A two way repeated measures analysis of variance was performed to determine if significant differences existed between groups (CP vs. DP firstly, and CP vs. EP secondly) and testing. RESULTS CP vs. DP: Both groups became heavier and larger during the season ( $p < 0.001$ ). However, at the end of the season CP were significantly taller and heavier ( $p < 0.05$ ). Also, although performance improvements were observed during the season in both groups, improvements were larger in CP (velocity and agility,  $p < 0.001$ ; Yo-Yo IR1,  $p < 0.05$ ; CMJ,  $p < 0.01$ ). No interaction (group x time) was observed in anthropometry, performance or maturation. CP vs. EP: No anthropometrical changes were observed in EP. However, the analysis revealed that CP were significantly lighter and shorter ( $p < 0.05$ ). Regarding performance, significant improvements were observed in both groups ( $p < 0.05-0.001$ ). Also, EP appeared to be significantly closer to their maturity offset than CP. No interaction (group x time) was observed in anthropometry, performance or maturation. CONCLUSION Results indicated that anthropometrical and physical performance characteristics can differentiate between players who are selected from those who are not. Whereas improvements in performance during the season appeared to be the main reason to pass to the next category within the academy, maturation and body size appeared to be the reason for being selected to play in the club. Thus, different indicators seem to be important for coaches when selecting or promoting players.

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### COMPARISON OF THE ENERGETIC PROFILE, TIME-MOTION AND TECHNICAL ACTIONS BETWEEN SMALL VS. LARGE-SIDED SOCCER GAMES

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Introduction Smaller (e.g. 1vs1) and larger game formats (e.g. 6vs6) are recommended for the anaerobic- and aerobic training, respectively, based on the responses of heart rate and blood lactate (Hill-Haas et al., 2009). Only by using heart rate and blood lactate, however, it is not possible to calculate the relative energy contributions from the aerobic and anaerobic energy system. Therefore, the aim of this study is to compare the energetic profile between smaller and larger game formats in relation of time-motion and technical actions. Methods Eleven U-16 elite junior soccer players (15.8±1.0 yrs, 66.3±8.2 kg, 1.75±0.1 m) participated in this study during in-season period. 2vs2 and 6vs6 were chosen as smaller and larger format, played with 2 and 4 min of one bout, respectively. The energy profiles were calculated based on the accumulated oxygen uptake above rest (aerobic, [Aer]), fast component of the post-exercise oxygen uptake (anaerobic lactic, [AnAla]), maximum net accumulation of blood lactate (anaerobic lactic, [AnLa]) (Beneke et al., 2004) using portable spirometry (MetaMax 3B, GER) and lactate determination (BIOSEN S\_line, GER). Time-motion analysis was completed (SPI Pro 5 Hz, AUS) and all game sessions were recorded using a video camera to obtain the number of technical actions. Paired sample t-test was used to compare the differences in each variable between two game formats. Results The Aer share for 2vs2 (69.5±5.8%) was significantly lower than that for 6vs6 (87.6±2.4%, p<0.001), while the share of both AnAla and AnLa for 2vs2 (21.1±3.8% / 9.4±4.8%, respectively) was significantly higher than those for 6vs6 (10.1±2.6% / 2.3±1.0%, respectively, p<0.001). There was no significant difference in the sprint distance (>18km/h) between 2vs2 and 6vs6 (11.5±4.1m / 20.9±7.4m, respectively). There were no significant differences in the number of ball contacts between 2vs2 and 6vs6 (12.1±4.3 / 7.7±4.4, respectively). Discussion The AnAla and AnLa shares were recruited in a higher percentage during 2vs2 than during 6vs6, confirmed by no differences in the sprint distance covered and the number of ball contacts during 2vs2 despite the shorter duration of 2min. However, even when smaller game format (2vs2) and short times (2min) are used in training the aerobic share is still dominant and gives only a stimuli of secondary importance to the anaerobic-lactic system. References Beneke R, Beyer T, Jachner C, Erasmus J, Hütler M. (2004). *Eur J Appl Physiol*, 92, 518-523. Hill-Haas, S et al. (2009). *J Sports Sci*, 27(1), 1-8. Contact inehwan@gmail.com

### AGE-RELATED DIFFERENCES IN COUNTERMOVEMENT VERTICAL JUMP IN BASKETBALL PLAYERS 13-18 YEARS OLD: COMPARISON WITH ELITE BASKETBALL PLAYERS.

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Introduction The aim of this study was to examine the effect of age on leg muscle strength and power in youth basketball players and compare them with elite basketball players. Methods Fifty two basketball players, all members of competitive basketball clubs and classified into 4 age groups (G1=13-14, n=15; G2=15-16, n=15; G3=17-18, n=6; G4pros=20-33, n=16, years of age) participated in this study. They were examined for anthropometric characteristics, and performed a free arm counter movement jump and an isokinetic knee test using the Humac Norm dynamometer. They were examined for anthropometric characteristics, and performed the arm-swing counter-movement vertical jump (CVJ) as a measure of leg muscle power. The maximal isokinetic peak torque of the knee extensor and flexor muscles was recorded at two angular velocities (60°s<sup>-1</sup>, 300°s<sup>-1</sup>) for both the dominant and non-dominant legs. Results A one-way analysis of variance revealed significant differences between age groups with respect to CVJ (F<sub>3,51</sub> = 19.57, p < 0.001, η<sup>2</sup> = 0.55). The findings indicated significant increase of CVJ with age except between G2 and G3 (e.g., 39±5.92 cm in G1, 41.52±3.48 cm in G2, 41.50±1.98 and in G4pros 54.43 ±8.96). There was no significant difference between dominant and non-dominant leg at both angular velocities (both p > 0.05) for all age groups. With respect to the isokinetic measurements professional basketball players exhibited significantly higher values in both angular speeds versus the rest of the groups (p<0.05). Significant positive correlations (all p < 0.0001) were detected between the isokinetic measures of the knee extensors and flexors and the CVJ for both angular velocities. Discussion It is reasonable to suggest that there are large increases in fat free mass with development in basketball players and consecutively increases in leg muscle power, even though these differences are minimized in groups that have small age differences. These gains are accompanied by large increase on performance measured with the isokinetic device and the CVJ. The findings of this study could be useful in the context of talent identification and training optimization. Contact Koulla Parpa kparpa@uclan.ac.uk

### WARM-UP FOR TEAM SPORTS: A DESCRIPTIVE REVIEW OF STUDIES AND PROCEDURES

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Introduction Several attempts have been carried out in the last years to establish a methodology and a set of actions that may be implemented in team sports warm-up, increasing athletes' performance and avoiding injuries. Well-structured protocols have been proven effective to enhance power and prevent injuries in sports like basketball, handball, volleyball and soccer. Nevertheless, further studies should be reviewed to improve and generalize this effectiveness to some other disciplines. Methods Twenty-five research articles were analyzed to study warm-up effects and procedures for team sports. For inclusion, studies were required to be (i) intervention studies or meta-analysis; (ii) include a quantitative outcome assessment; (iii) be published later than December 2004. Results Sixteen percent of the studies evaluated warm-up duration with agreement on an activity length between 10 and 20 minutes and a pre-match recovery of 5 to 10 minutes. Forty-four percent of the studies considered dynamic stretching activities in their routines, with all of them finding a benefit over static stretching exercises in power, jump and agility and noticing suitability in young athletes. Equipment use was observed in 28% of the studies, with benefits in the adoption of vibration plates, weights and muscular belts in subsequent explosive actions despite not noticing clear benefits on the use in expert athletes. Six studies assessed the injury reduction derived from the use of warm-up protocols with 60% finding positive interaction with long-term injury reduction, especially in muscles and tendons. Warm-up routines prove not clear decrease in post-exercise muscle soreness up until now. Discussion Team sports are activities with high demands of power actions such as jumping, throwing and hitting. Most of them have strenuous actions with contact. The use of warm-up activities with a length over 10 minutes, incorporating dynamic stretching (Behm and Chaouachi, 2011) and equipment to improve postactivation potentiation and

neuromuscular demands (Bazzett-Jones et al., 2008) seems capital to improve performance (McMillian et al., 2006) and to reduce injuries (Steffen et al., 2013). Further experimental studies should be conducted to observe if any cumulative effect is produced by the use of all these strategies together. References Bazzett-Jones DM, Finch HW, Dugan EL. (2008). *J Sports Sci Med*, 7(1), 144-150. Behm DG, Chaouachi A. (2011). *Eur J Appl Physiol*, 11(11), 2633-51. McMillian DJ, Moore JH, Hatler BS, Taylor DC. (2006) *J Strength Cond Res*, 20(3), 492-9. Steffen K, Emery CA, Romiti M, Kang J, Bizzini M, Dvorak J, Finch CF, Meeuwisse WH. (2013). *Br J Sports Med*, 47(12), 794-802. Contact Javier.pena@uvic.cat

## Mini-Orals

### MO-PM39 Training and Testing: Team Sports II

#### THE EFFECTS OF RECOVERY TIME ON REPEATED SPRINT ABILITY IN SOCCER PLAYERS

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**Introduction** In the last few years, Repeated Sprint Ability protocols (RSA) have frequently been used for both team sports specific testing and training (Impellizzeri et al., 2008). The aim of this study was to assess the influence of different recovery times on RSA and muscular performances (Bosco et al., 1982). **Methods** Seventeen male soccer players (age 16±0 yrs; mass: 66±10 kg; height: 1.81±0.06 m; BMI: 20.1±2.0 kg•m<sup>-2</sup>) participated in this study and performed three RSA protocols (6×(20+20-m) with 180° change of direction with three different recovery times: 15/20/25-sec) on three different days (four days in-between). Before and after each RSA test blood lactate concentration (BLa) and counter movement jump (CMJ) were assessed. The reliability (Hopkins et al., 2000) of the measures was assessed by re-testing ten days later and calculating the intra-class correlation coefficient (ICC). ANOVA with repeated measures was applied to assess the effect of recovery times on all investigated variables. **Results** Good reliability (ICC) was found for the first sprint time (ICC=0.851) and CMJ height (ICC=0.860). 25-sec recovery improved test (-3% total time from 15-sec to 25-sec recovery, p=0.0013) and CMJ (+7% post-test height from 15-sec to 25-sec recovery, p=0.038) performances, while decreased BLa accumulation (-33% post-test from 15-sec to 25-sec recovery, p<0.0001). **Conclusions** This study contributes to tune RSA procedures recovery duration starting from usually field-chosen durations (~20 sec) and already literature-investigated durations (from 2-3 to 120 sec). By investigating performance, metabolic-anaerobic demand and muscular stretch-shortening performance variables in ecological conditions, it was found that the optimal recovery duration is 25 sec in order to practically maximize performance and contain metabolic-anaerobic power involvement and muscular stretch-shortening performance deterioration. In comparison with shorter recovery duration RSA tests, a 25-sec recovery one is featured by better overall performance and post-test muscular stretch shortening performance with lower anaerobic demand in young soccer players. **References** Bosco C, Ito A, Komi PV, Luhtanen P, Rahlkila P, Rusko H, Viitasalo JT. (1982). *Acta Physiol Scand*, 114(4), 543-550. Hopkins WG. (2000). *Sports Med*, 30(1), 1-15. Impellizzeri FM, Rampinini E, Castagna C, Bishop D, Ferrari Bravo D, Tibaudi A, Wisloff U. (2008). *Int J Sports Med*, 29(11), 899-905. Contact sportcinetic@gmail.com

#### ANALYSIS OF INTENSITY OF EXERCISE LOAD OF BASKETBALL PLAYERS IN A CHAMPIONSHIP MATCH IN THE CADETS CATEGORY – CASE STUDY

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**Introduction** The focus of this study is the analysis of the exercise intensity in a championship match in the Cadets category (U-16) of the top league. This is the crucial point for prescribing the effective training program since the relationship between the match and training exercise intensity is considered the key training problems of sport games including basketball (Kelly and Coutts, 2010). The aim of this case study was to monitor and analyze the progress of the exercise intensity during the championship match. in the Extra-league team of Cadets (U-16) **Methods** The heart rate of players (n=5; starting lineup only) was monitored using the Polar TEAM 2 system. The average HR is calculated only from the sections of the match where the players were actively involved in the game and the game clock was running (the so-called "live time") according to Abdelkrim et al. (2007). **Results** For starting lineup players, the average HR value was calculated as 176.1 ± 5.8 heart beats per minute, which corresponded to 90.6 ± 2.9 % of HRmax determined during the graded exercise test in the laboratory conditions. There was a significant decrease in the heart rate in the first vs. last quarter of the match comparison (5% significance level). **Discussion** The presented results showed very high exercise intensity (90.6 ± 2.9 % HRmax) during the real situations in the championship basketball match in U16 category. Similar results (91 % HRmax) have been published previously for 19-year-old basketball players (Abdelkrim et al., 2007) which may indicate non-dependence of the exercise intensity during the match on age category. There are, however, the important factors which have to be taken into account before relating these results to a certain individual. The performance in sport games can be influenced by a number of factors, such as a different player position or different role of each player performs in the team (Vala and Litschmannová, 2012). The training process in basketball, as well as in any sport, must be in accordance with the typical load requirements for the real championship match corresponding to a certain performance level. The obtained information about exercise loads in the championship match should be the basis for the subsequent creation of a training plan and selection of appropriate methodological and organizational types of practice of the same age and skill category (Kelly and Coutts, 2010). **References** Abdelkrim NB, El Faza S, El Ati J. (2007). Time - motion analysis and physiological data of elite under-19-yearold basketball players during competition. *British Journal of Sports Medicine*, 41, 69-75. Kelly VG, Coutts AJ. (2010). Planning and Monitoring Training Loads During the Competition Phase in Team Sports. *Strength & Conditioning Journal*, 29(4), 32-37. Vala R, Litschmannová M. (2012). Analýza intenzity zatížení hráčů v basketbalovém utkání- případová studie. *Česká kinantropologie*, 16 (1), 59-65.

#### THE INFLUENCE OF SMALL SIDED GAMES PITCH SIZE ON INTERNAL AND EXTERNAL LOAD

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**Introduction:** Small-sided games (SSG) enable coaches replicate tactical and technical skill production in game type situations (Hodgson, et al., 2014). The aim of the current study was to identify the impact of SSG pitch dimension on the external and internal load placed on



hurling players. Methods: Twenty-four male hurling players were monitored during training games using heart rate monitors (Suunto, Finland) and 4 hz global positioning satellite systems (VX Sport, New Zealand). Players participated in 4v4 SSG of varying pitch dimensions 40x20m, 60x20m, 80x20m (n=990). Percentage of heart rate maximum (%HRmax), total distance (m), high speed (>17 km.hr-1) distance (m), peak speeds (km.hr-1) and the number of accelerations were considered. A multiple analysis of variance was used to analyse pitch size differences across internal and external load metrics with statistical significance set a  $p \leq 0.05$ . A least significance difference post hoc test was used to identify differences between pitch dimensions. Data is reported as mean  $\pm$  sd. Results Percentage of heart rate maximum were significantly higher (80x20m -  $98 \pm 8\%$ ; 60x20m -  $96 \pm 7\%$ ; 40x20m -  $82 \pm 11\%$ ;  $p = .003$ ) in the 80x20m playing area. The total distance covered was significantly higher in the larger playing area (80x20m -  $729 \pm 185$ m; 60x20m -  $509 \pm 145$ m; 40x20m -  $298 \pm 89$ m;  $p < .001$ ). Similar trends were seen across high speed ( $\geq 17$ km.hr-1) distance (80x20m -  $298 \pm 127$ m; 60x20m -  $198 \pm 93$ m; 40x20m -  $76 \pm 25$ m;  $p = .002$ ). Peak speeds were significantly higher in the 80x20m playing area (80x20m -  $29.1 \pm 3.6$  km.hr-1; 60x20m -  $26.1 \pm 3.3$  km.hr-1; 40x20m -  $22.5 \pm 2.4$  km.hr-1;  $p = .004$ ). The larger pitch dimensions resulted in a greater number of accelerations being completed (80x20m -  $44 \pm 10$ ; 60x20m -  $30 \pm 10$ ; 40x20m -  $15 \pm 3$ ;  $p = .002$ ). Conclusion The findings of the current study indicate a manipulation of pitch dimensions in hurling SSG can be used to change the internal and external load placed on players. The current data may be utilised to guide coaches who use SSG as a training methodology. References Hodgson C, Akenhead R, Thomas K. (2014). *Human Mov Sci*, 33, 25-32 Contact: shane.malone@mymail.ittdublin.ie

### EARLY PREDICTION OF MAXIMAL HEART RATE DURING INCREMENTAL TESTING IN YOUNG SOCCER PLAYERS

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Introduction The maximal heart rate (HRmax) is commonly used for monitoring training intensity in soccer. HRmax is typically measured by means of tests requiring an exhaustive effort. Age-based predictions are also used, but such approach tends to have substantial prediction errors. In a recent study (Baralis et al., 2013), it was shown that parameters associated to maximum effort during an incremental cycle ergometer test can be early predicted by the HR and ventilatory responses to the initial submaximal stages of the test. Thus, the purpose of this study was to evaluate the effectiveness of estimating HRmax from HR responses measured during the first phase of a graded running test. Methods 29 young soccer players (mean (SD) age: 16 (0.3) yrs, height: 174.2 (6.2) cm, weight 62.9 (5.6) kg) completed an incremental running test on an oval track, with speed set at 8.5 km/h and increased by 0.5 km/h every minute until exhaustion (Leger et al., 1988). Beat-by-beat HR was assessed throughout the test. HRmax was calculated as the peak HR value of 5-s segments. For each of the players, the slope and intercept of the HR vs. time relationship were estimated using HR data measured from the third to the sixth minute of the test, and used to predict HRmax with a linear regression. Results The mean HRmax and test duration were 202.1 (7.3) bpm (range: 187 to 216), and 809 (100) s (range: 625 to 1020). The linear model with (HR vs. time) slope and intercept as predictors explained 65% of variance in HRmax. The mean residual between the actual and predicted HRmax was 0 (3.8) bpm (range: -9.2 to 10.3). Discussion The present findings show that HRmax can be predicted with a reasonably little error (< 5%) using HR vs. time relationship determined in the early stages of an incremental test (up to a 11 km/h running speed) in young soccer players. The approach of estimating maximal parameters from responses to non-exhaustive incremental exercises seems a promising tool for testing competitive athletes without requiring a maximal effort. References Baralis E, Cerquitelli E, Chiusano S, D'Elia V, Molinari R, Susta D. (2013). *ACM Trans Interact Intell Syst*, 4, 70. Leger L, Mercier D, Gadoury C, Lambert J (1988). *J Sports Sci*, 6, 93-101. Contact rocco.dimichele@unibo.it

### PERFORMANCE CHANGES IN WOMEN'S HANDBALL PLAYERS FOLLOWING TWO DIFFERENT TRAINING PERIODIZATION MODELS

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Purpose This study was undertaken to compare training-induced changes in selected physiological, body composition and handball key performance factors following two training periodization models: traditional versus block periodization. Methods Eleven women's HB players from a first league team were assessed four times during a training cycle over two consecutive seasons. On each occasion, subjects completed a 20m maximal sprint test, a treadmill incremental test to exhaustion to determine  $VO_{2max}$ . Maximal dynamic strength 1-repetition maximum (1RM) for upper bench press and lower half-squat body, maximal isometric hand grip force, as well as explosive strength test for upper (throwing velocity) and lower extremities (countermovement and squat jumps) were assessed. Anthropometric measurements including height, body mass and body mass index were also obtained. Results Both, Traditional and Block Periodization cycles resulted in gains in lower extremities explosive strength, maximal dynamic strength and 20m sprint test, but following Block Periodization players experienced significant larger gains. Additionally, meaningful improvement were found in throwing velocity in all modalities only in the Block model. Conclusions These findings suggest that Block Periodization may be more effective than Traditional Periodization for improving the most important Handball performance factors in a Spanish first league women's Handball team.

### MEASURING GAME INSIGHT SKILLS OF ELITE YOUNG FOOTBALL PLAYERS

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The aim of the study is to examine the game insight of talented young elite soccer players using a video temporal occlusion technique paradigm (1). Focussing on their performance in 4-vs-4 (2) and 11-vs-11 (3) football games and cognitive functioning (4) by the Attention Networking Test (ANT). Eight coaches judged independently several 4 by 4 games and were asked to rank players according to their game insight abilities. This rating is novel compared to other studies and will validate all other variables used. In the video occlusion task the players had to anticipate the trajectory of an oncoming ball. During the task the visual information is temporal occluded at 80 ms before ball contact (-80 ms), at ball contact (0 ms) or 80 ms after ball contact (+80ms). Two groups were created based on the coaches ratings: one with a high level of game insight (HL; n=5) versus one with a lower level of game insight (LL, n=6). For the video task a significant interaction is found for group by occlusion ( $F(2, 11.8) = 5.26$ ,  $p = 0.034$ ). The HL group scored significantly better in the 0 and +80 ms contact conditions. In addition HL group performed significantly better in the 4-4 games ( $t(5.8) = 6.86$ ) as well in the 11-11 games ( $t(8.3) = 4.5$ ). No differences between groups were found with respect to the cognitive tests. The findings indicate that the video occlusion task proved to be a valid differentiator for measuring game insight in young football players.

**COMPLEX STAGE TESTING IN YOUNG SOCCER PLAYERS**

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COMPLEX STAGE TESTING IN YOUNG SOCCER PLAYERS Introduction Successful training of the athlete is provided by qualitative stage control for informative and reliable indicators about athlete current conditioning. Because of early sport career beginning, increase in competitive and training loads at the initial stage of sport training regular control of young athletes is of great importance. The aim of the research was to estimate a physical fitness level of young football players and to give coach recommendations about training program design. Methods A group (n = 29) of young football players with 3 years of sport experience (age 9 – 10) was examined. The multifrequency bioimpedance segmental body composition monitor "Tanita MC-980" was used for full body composition analysis. The impedance cardiography was held for an express assessment of athletes cardiohemodynamics. The quality of regulation of athlete organism was estimated with active ortho- and clinostatic tests. Jumping testing allowed to estimate feet power and jumping technique. Running high intensity interval testing (Tabata Protocol) was held to analyze the development of speed and power abilities and specific endurance. Heart rate monitoring with GPS (Forrunner 310XT) was used to measure the distance length covered in each intensive bout in outdoor activity. Results 20,6% examined athletes have low body fat, 35% have insufficient body weight and 41% of football players have significant deficiency of body weight. The majority of cardiohemodynamic indicators are inside age norm frames. Increased heart and breathing rate at rest, hypovolemia  $-57 \pm 18,9\%$  (hypovolemia is a state of decreased blood volume in blood vessels; in healthy children closely connected with dehydration) and increased cardio contractility function ( $52 \pm 18,7$ ) are revealed. All young athletes have a good tolerance of functional tests. There are unequal level of speed and speed endurance among the football players of 9-10 years and mistakes in running technique. Discussion It is necessary to enlarge water and nutrition intake according to the nature of physical activity of football players and its intensity. For improvement of aerobic capabilities it is recommended to increase a number of low intensive (HR=  $120 \pm 10$  bpm) aerobic trainings, power training without accelerations paying more attention to a complete recovery and relax exercises for recovery. The majority of running technique mistakes are connected with lack of strength in corresponding muscles groups. That is why strength enhancement is recommended individually. For development of the main soccer skills and feet explosive force foot exercises for ligaments and tendons should be included in training process. It is also recommended to include hopping (jumping) part with emphasis on high-quality performance of each element and the position of foot during jumps. Contact sport\_tsp@mail.ru

**Mini-Orals****MO-PM40 Training and Testing: Endurance****ACCURACY OF PREDICTIVE MAXIMAL HEART RATE EQUATIONS IN FEMALE ATHLETES**

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Introduction: Athletes often use maximal heart rate (HRmax) as a guide to developing their training and conditioning programs. There are a number of published HR (heart rate) equations in the literature, but few have been validated on female athletes. The purpose of this study was to determine the accuracy of three general and two female-specific age-predicted HRmax prediction equations in female collegiate athletes. Methods: Thirty female collegiate athletes (age =  $21.5 \pm 1.9$  years, height =  $164.7 \pm 6.6$  cm, weight =  $61.3 \pm 8.2$  kg) participated. HRmax was determined by a maximal treadmill graded exercise test (Bruce protocol). Expired gas fractions were evaluated with a metabolic cart (ParvoMedics TrueOne® 2400, Sandy, UT). The test was terminated when the participant reached at least two of the criteria for maximal oxygen consumption (VO<sub>2</sub>max) as follows: a plateau in VO<sub>2</sub> ( $\pm 2$  ml.kg<sup>-1</sup>.min<sup>-1</sup>) with increasing work rate; respiratory exchange ratio > 1.10; Ratings of Perceived Exertion of at least an 8 out of 10; or volitional fatigue. Predictions were evaluated with three general equations (Fox et al., Astrand, and Tanaka et al.) and two female specific equations (Fairbairn et al. and Gulati et al.). Means and standard deviations were determined for the observed and predicted HRmax values, which were compared with repeated measures analysis of variance followed up with paired T-tests. A Bonferroni adjusted p-value was applied to reduce the chances of obtaining a type I error when multiple pairwise tests were performed, which resulted in an adjusted alpha level for significance of  $p < 0.01$ . Results: There was no significant difference between observed HRmax ( $185.9 \pm 5.0$  beats.min<sup>-1</sup>) and the Fairbairn ( $187.5 \pm 1.2$  beats.min<sup>-1</sup>) and Gulati ( $187.1 \pm 1.7$  beats.min<sup>-1</sup>) equations ( $p = 0.11$  and  $0.23$ , respectively). The Fox ( $198.5 \pm 1.9$  beats.min<sup>-1</sup>), Astrand ( $198.1 \pm 1.6$  beats.min<sup>-1</sup>), and Tanaka ( $193.0 \pm 1.4$  beats.min<sup>-1</sup>) equations provided significantly higher estimates compared to observed HRmax ( $p < 0.001$  for each). The standard error of the estimate was similar for all the prediction equations (between 5.0 and 5.4 beats.min<sup>-1</sup>), but the total error was smallest for Fairbairn and Gulati (5.3 beats.min<sup>-1</sup> for each) and largest for Fox and Astrand (13.9 beats.min<sup>-1</sup> and 13.3 beats.min<sup>-1</sup>, respectively). The 95% limits of agreement of the mean error were similar for all of the prediction equations with values varying between 9.9 and 10.5 beats.min<sup>-1</sup>. Conclusions: The female-specific HRmax equations of Fairbairn et al. and Gulati et al. provided the most accurate mean values. However, all of the equations that were analyzed in the study provided large limits of agreement and showed tendencies to over-predict HRmax especially among the participants with lower observed values. Due to the wide limits of agreement displayed by each equation, the use of age-predicted methods for estimating HRmax in collegiate female athletes should be used with caution when using HRmax prediction equations.

**RELATIONSHIP BETWEEN AEROBIC FITNESS AND MATCH ACTIVITY PROFILES OF JAPANESE YOUNG SOCCER REFEREES**

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INTRODUCTION: Previous studies have demonstrated that, in experienced Italian elite-level referees, both maximal oxygen uptake (VO<sub>2</sub>max) and running speed at blood lactate concentration of 4 mmol/L (onset of blood lactate accumulation; OBLA) were correlated with the total distance covered, with VO<sub>2</sub>max being slightly a better predictor of the total distance than was OBLA 1), 2). Whereas, neither VO<sub>2</sub>max nor the speed at OBLA (s-OBLA) were correlated with the distance covered at high intensity running (HIR:  $\geq 15$  km/h). In these studies, however, video images were used to calculate running speeds, with which the accuracy may be limited. Moreover, the definition of HIR differed from what has been accepted in recent studies (HIR:  $\geq 18.1$  vs.  $15.0$  km/h) 3). Therefore, further investigations for the corre-

lation between the aerobic fitness parameters (VO<sub>2</sub>max and s-OBLA) and the match activity profiles may be warranted. Moreover, compared with the quantity of information for elite-older referees, there is paucity of data for young referees. Thus, this study was aimed to investigate the relationship between aerobic fitness parameters and match activity profiles of Japanese young soccer referees. METHODS: Fourteen Japanese male referees (26 ± 3 year-old) completed a submaximal incremental treadmill test to determine the running speed at the onset of blood lactate accumulation (s-OBLA) and to estimate VO<sub>2</sub>max from the heart rate. Match activity profiles (total distance, HIR and distances from fouls) were calculated during competitive matches using data recorded from a GPS device and a video camera. RESULTS: Total distance covered during a match was 11.3 ± 0.6 km, 1.9 ± 0.4 km was covered at HIR, and the mean distance from fouls was 14.4 ± 1.0 m. The s-OBLA ranged between 12.6–16.3 (14.5 ± 1.0) km/h, which was correlated positively with the distance covered at HIR ( $r = 0.77$ ;  $p < 0.05$ ) and negatively with the mean distance from fouls ( $r = -0.62$ ;  $p < 0.05$ ). However the estimated VO<sub>2</sub>max was not related to these variables ( $p > 0.05$ ). DISCUSSION: A high frequent occurrence of HIR during a match 4) may necessitate the ability to counter fatigue development. The submaximal aerobic parameters such as s-OBLA may better reflect this type of ability, compared to VO<sub>2</sub>max; an index of maximal aerobic power at fast speed but for a limited duration. Thus, OBLA assessment may provide good indices of fit young referees who can cover longer distances at high intensity speed and judge closer to a foul play. 1). Castagna C, D'Ottavio S. (2001) J. Strength Cond. Res. 15(4), 420-5. 2). Castagna C, Abt G, D'Ottavio S. (2002) J. Strength Cond. Res. 16(4), 623-7. 3). Abt G, Lovell R. (2009) J Sports Sci. 27(9), 893-8. 4). Krstrup P, et al. (2009) J Sports Sci. 27(11), 1167-76.

## COMPARISON OF OXYGEN UPTAKE KINETICS DURING LABORATORY AND FIELD CYCLING AT HIGH-INTENSITY EXERCISE

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Introduction The primary response of oxygen uptake to a step increase to a high-intensity work rate is typically investigated in a laboratory setting. Despite the high ecological validity of field tests only a few studies examined oxygen uptake kinetics in field conditions. The aim of this study was to compare the primary response of oxygen uptake between laboratory and field conditions. Methods Thirteen competitive male cyclists (age: 23 ± 4.7 y; stature: 178.5 ± 5.2 cm; body mass: 69.0 ± 7.8 kg; VO<sub>2</sub>max: 68.2 ± 4.7 mL/min/kg) performed an incremental graded exercise test to determine the ventilatory threshold (VT) and Pmax. On two separate days participants performed two trials of 6 min duration at the intensity corresponding to 70% between VT and Pmax (Delta70%) at two cadences (60 and 90 rpm) in field and laboratory conditions. Breath by breath ventilation and oxygen uptake was measured with a portable gas analyser (MetaMax3B, CORTEX, Germany) and power output was measured with a SRM mobile power crank (Schoberer Rad-Messtechnik, Juelich, Germany) mounted on a 26-inch mountain bike. The time constant and the amplitude of the exponential primary response were resolved by least square regression. A factorial ANOVA with cadence and condition as model factors was used for statistical analyses. Results The amplitude was significantly affected by cadence (F<sub>1,12</sub> = 10.9, P = 0.006; 60 rpm: 2488 ± 394 mL, 90 rpm: 2697 ± 306 mL) and condition (F<sub>1,12</sub> = 19.2, P = 0.001; field: 2730 ± 408 mL, laboratory: 2455 ± 286 mL). The time constant was not significantly affected by cadence (F<sub>1,12</sub> = 0.2, P = 0.702; 60 rpm: 22.3 ± 4.6 sec, 90 rpm: 22.8 ± 2.4 sec) and condition (F<sub>1,12</sub> = 3.2, P = 0.1; field: 24.0 ± 4.4 sec, laboratory: 21.1 ± 3.8 sec). The end-exercise oxygen uptake was significantly affected by cadence (F<sub>1,12</sub> = 29.7, P < 0.001; 60 rpm: 4094 ± 466 mL, 90 rpm: 4383 ± 471 mL). No significant difference was observed between field (4246 ± 526 mL) and laboratory conditions (4232 ± 427 mL) (F<sub>1,12</sub> = 0.03, P = 0.859). Discussion In accordance with previous studies in trained athletes, a higher cadence has no effect on the time constant despite a higher amplitude and end-exercise oxygen uptake. The higher amplitude and the tendency to a slower (i.e. higher) time constant, indicate a higher energy demand and an impaired primary response of oxygen uptake in field compared to laboratory conditions. Whether or not these findings affect exercise tolerance or time-trial performance in field or laboratory conditions remains to be shown. Contact bernhardbp@gmx.at

## THE D-MAX METHOD IS A VALID LACTATE THRESHOLD MEASUREMENT FOR PREDICTING 5-KM TREADMILL RUNNING PERFORMANCE IN VETERAN ATHLETES

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Introduction Measuring lactate threshold to predict endurance performance is difficult among veteran athletes, due to an age-related decline in type 2 muscle fibres. Using absolute values of blood lactate to determine lactate threshold, such as the 4 mmol/L method or onset of blood lactate accumulation (OBLA), are not appropriate, especially if net lactate concentration is too low for a threshold to be accurately detected. The purpose of this study was to determine whether the lactate threshold, as assessed using the maximal deviation method (Dmax) (Cheng et al., 1992), which is not dependent on absolute values of lactate, could be used as a valid measure of 5-km running performance. Methods A total of 36 veteran runners (18 male and 18 female) (mean±SD, age 47.3±6.7 years) performed an incremental exercise test to establish mean treadmill velocity and mean heart rate at Dmax, and on a separate occasion, completed a 5-km time trial. Results Mean treadmill velocity and heart rate at Dmax were 12.2±1.8 km/h and 157±12 beats/min, respectively, not being significantly different to values (12.1±1.8 km/h and 159±11 beats/min, respectively) attained during the 5-km time trial (t(35)=-1.06, p=.30 and t(35)=.78, p=.44, respectively). Mean treadmill velocity at Dmax and during the 5-km time trial were significantly correlated ( $r = .92$ ,  $p < .001$ ), as were mean heart rate ( $r = .57$ ,  $p < .001$ ). Limits of agreement were -1.61 to 1.35 km/h, and -20.6 to 23.5 beats/min. In contrast, when an absolute value of 4 mmol/L of blood lactate was used, differences were significant for both velocity (t(35)=-4.49,  $p < .001$ ) and heart rate (t(35)=-1.89,  $p = 0.01$ ), limits of agreement were wider (e.g., -6.1 to 5.5 km/h), and correlation was lower (e.g.,  $r = .47$  for heart rate). Discussion Mean treadmill velocity and heart rate at Dmax for determining lactate threshold is useful for predicting 5-km running performance among male and female veteran athletes. This finding is in agreement with that of Fell (2007), who suggested that the Dmax method was a good predictor of endurance performance in well-trained, veteran cyclists, and with Machado et al. (2011), who found that the Dmax method correlated more strongly with 10-km road race performance among recreational, female, veteran runners, than did OBLA. The Dmax method can therefore, be used for predicting 5-km performance time among veteran runners. References Cheng B, Kuipers H, Snyder AC, Keizer HA, Jeukendrup A, Hesselink, M. (1992) Int J Sports Med, 13(7), 518–522. Fell JW. (2008). J Sci Med Sport, 11(5), 460-463. Machado FA, de Moraes SMF, Peserico CS, Mezzaroba PV, Higino WP (2011). Int J Sports Med, 32(9), 672-676.

**INTERVAL SPRINT TRAINING INCREASES AEROBIC CAPACITY IN PRIMARY SCHOOL CHILDREN**

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Introduction Intensive interval endurance training is a natural exercise for children and increases their aerobic fitness (Bailey et al. 1995; Baquet et al. 2003). Additionally, compared to continuous endurance training methods, it is time saving, and therefore of special interest for physical education in primary school. The aim of the present study was to compare the effects of playful interval sprint training and continuous endurance training on aerobic fitness, sprint performance and body composition as well as exercise tolerance and acceptance in primary school children. Methods During a 10-week intervention the effects of playful interval sprint training (INT, n=16) and continuous endurance training (CT, n=16) compared to a non-training control group (CON, n=10) were examined in 42 children (9.5±1.1 yrs; Tanner Stage <2). Each participant completed a paediatric examination as well as a pre- and post-diagnostic to determine anthropometry, aerobic fitness (e.g. peak oxygen uptake (VO<sub>2peak</sub>) and sprint performance (20 m). INT consisted of 30 min intensive interval sprint and game forms (5-15 sec bouts). CT consisted of 50 min extensive continuous run and game forms. The participants rated their acceptance of each training session by a scale of marks from 1 (very good) to 5 (poor). During two training sessions maximum blood lactate concentrations (LA) and mean heart rates (HR) were determined. Results Each participant of the training groups completed 19 (of maximum 20) training sessions. LA was significantly higher and HR significantly lower during INT (LA 2.6±0.8 mmol/l, HR 145±14 bpm) compared to CT (LA 1.3±0.4 mmol/l, HR 158±137 bpm). Acceptance was significantly higher in INT (1.3±0.3) compared to CT (1.8±0.8). VO<sub>2peak</sub> was significantly improved after INT (20%) and CT (19%), but not in CON (4%). Body mass showed a significantly lower increase after INT (3.5%) and CT (3.1%) compared to CON (6.5%) (p<0.05). Sprint performance remained unchanged in all groups (p>0.05). Discussion Playful interval sprint training shows equal results in aerobic fitness as continuous endurance training does, both without individual intensity control. Moreover, improvement in VO<sub>2peak</sub> exceeds the results of previous studies (Baquet et al., 2010; Matos and Winsley, 2007). Time saving of about 40% and high compliance offer new perspectives for fitness- und health related endurance training in school sport. References Bailey RC, Olson J, Pepper SL, Porszasz J, Barstow TJ, Cooper DM (1995). *Med Sci Sports Exerc*, 27, 1033-1041. Baquet G, Gamelin FX, Mucci P, Thénevet D, van Praagh E, Berthoin S (2010). *J Strength Cond Res*, 24, 1381-1388. Baquet G, van Praagh E, Berthoin S (2003). *Sports Med*, 33, 1127-1143. Matos N, Winsley RJ (2007). *J Sports Sci Med*, 6, 353-367. Contact jennifer.kappenstein@rub.de

**A SPECIFIC REPEATED SPRINT ABILITY TEST FOR YOUNG TENNIS PLAYERS: VALIDITY AND VENTILATORY CHANGES**

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INTRODUCTION: The ability to repeat high-intensity specific efforts or sports movements during a match (repeated sprint ability, RSA), is defined by the ability to perform maximal or near-maximal efforts <10 sec, with incomplete rest intervals (Girard, Mendez-Villanueva, & Bishop, 2011). Most used tests consist of 6-15 rep of 30-40 m with 25 sec rest (Chaouachi et al., 2010). Aiming to give validity to RSA tests, several studies have used the category/ranking as a construct (Wilkinson, McCord, & Winter, 2010), but participants in those studies were largely heterogenous. Therefore, in this study, a specific and reliable test for young tennis players has been used to provide the construct validity of the RSA. METHODS: 14 males tennis players were divided into two groups based on their result in the RSA test (high performance; low performance; n=7, each). The RSA test was V-shaped and consisted of 20 m with 3 changes of directions (COD) (two of 180° and one of 90°). Each participant carried out 6 reps of a RSA circuit initiated every 20 seconds. Total time (TT) of RSA ( $\sum$  of 6 repetitions), time required to change of direction (CODA),  $\sum$  of both 180° COD, fatigue index (FI) and the VO<sub>2</sub> during the test were analyzed. In addition, the evolution of lactate concentration (Lac) in capillary blood was analyzed at the end of the RSA test, an anthropometry was used to determine fat mass, and a 20m test, as well as a maximal oxygen uptake test were also performed. RESULTS: Bivariate correlations were made for all the data, and a paired t-test was used to find differences between both groups. Significant correlations were found between TT and: a) velocity in 20m (r = 0.765); b) CODA (r = 0.638); and c) Lac at 3 (r = -0.599) and 7 min (r = -0.540) post-RSA. However, TT did not correlate with VO<sub>2max</sub> or VO<sub>2</sub> during the test, neither with % fat mass, nor ranking. The FI did not correlate with any other variable. A significant difference was found in TT (p = 0.004) and in CODA (p = 0.024) between groups. CONCLUSIONS: The 20m sprint (Pyne, Saunders, Montgomery, & Hewitt, 2008) and CODA seem to be the most important validity variables. Nevertheless, ranking or VO<sub>2max</sub> were not good validity criteria. REFERENCES: Chaouachi, A., et al. (2010). *The Journal of Strength & Conditioning Research*, 24(10), 2663-2669. Girard, O., Mendez-Villanueva, A., & Bishop, D. (2011). *Sports Medicine*, 41(8), 673-694. Pyne, D. B., Saunders, P. U., Montgomery, P. G., & Hewitt, A. J. (2008). *The Journal of Strength and Conditioning Research*, 22(5), 1633-1637. Wilkinson, M., McCord, A., & Winter, E. M. (2010). *The Journal of Strength and Conditioning Research*, 24(12), 3381-3386.

**EFFECT OF DIFFERENT TIME-AVERAGING INTERVALS ON THE VALID DETERMINATION OF VO<sub>2</sub>PEAK IN CHILDREN AND ADOLESCENTS WITH CHRONIC KIDNEY DISEASE**

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Introduction: The oxygen uptake applies in sports medicine to an important gross criterion for the evaluation in physical capacity of individuals. Children and adolescents with chronic kidney disease have a lower oxygen uptake compared to healthy subjects and indicate in cardiopulmonary exercise tests (CPETs) a shorter exposure time. They cannot reach maximum oxygen uptake with plateau formation on the basis of the renal disease, therefore subjective exhaustion is selected (VO<sub>2peak</sub>). Point in time, there is no standard in the determination of VO<sub>2peak</sub> given, in regard to the time-averaging interval of data. Because of the lack of standard, the aim of this study was to determine VO<sub>2peak</sub> by modified time-averaging intervals at CPETs of children and adolescents with chronic kidney disease. Methods: In this study, 28 CPETs of chronic kidney diseased children and adolescents (sex: m=23, f=5; age: X= 15.0±15.3 years; body weight: X= 49.3±15.6 kg; body height: X= 158.5±18.5 cm) were evaluated. The test protocol was adapted to the performance of the children, the Godfrey protocol was chosen. In the analysis of CPET three different time-averaging intervals were selected: 10 sec, 20 sec and 30 sec without data smoothing. Results: There were significant differences between the averaging interval 10 sec (X = 1.241±0.380 l/min) 20 sec (X = 1.152±0.343 l/min) and 30 sec (X = 1.124±0.331 l/min). Discussion: For this patients a modified time-averaging interval of 10 seconds in a one-minute test protocol is recommended. Longer time-averaging intervals cannot validly determine the oxygen uptake. Reasons are no plateau in oxygen uptake and the time-limited VO<sub>2peak</sub>. Exercise physiologists need to verify this data-processing from maximal and peak oxygen uptake in this patients. References: Bergen M, Takken T, Engelbert R, Groothoff J, Nauta J, Hoeck K, Helders P, Lilien M.

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### IS HEART RATE A VALID MEASURE TO MONITOR EXERCISE INTENSITY DURING TRAIL RUNNING IN UNDULATING TERRAIN?

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**Introduction** During incremental lab tests, heart rate linearly increases and correlates with oxygen uptake and energy expenditure (Saltin et al. 1968, *Circulation*). Therefore heart rate is commonly used by athletes and coaches to control and evaluate exercise intensities in training and competition. During trail running however, the metabolic demand of the working muscle quickly changes due to steep up- and downhill sections and different surface conditions (i.e. forest tracks, dirt roads, gravel, rocks, wood and various other obstacles) (Jensen et al. 1999, *J Sports Sci*). It remains unclear, whether heart rate adequately reflects exercise intensities during high intensity trail running in challenging undulating terrain. **Methods** After the determination of running economy and maximal oxygen uptake (VO<sub>2</sub>max) in an incremental lab test, nine competitive runners (3 women: 31.3±8.5 yrs, 61.7±3.7 kg, 21.3±5.1%fat, 207±12 mL O<sub>2</sub>/kg/km, 53±3 mL/kg/min; 6 men: 28.9±4.1 yrs, 71.6±6.1 kg, 12.8±3.2%fat, 208±7 mL O<sub>2</sub>/kg/km, 65±5 mL/kg/min) performed a trail run time trial on an outdoor cross-country track consisting of two laps with 3 steep up- and 3 steep downhill sections each and variations in track surface (total distance: ~7km, total change in altitude: ~850m). Cardio-respiratory and global positioning data (MetaMax3B\_R2, Cortex, Leipzig, GER) were measured with a portable breath-by-breath gas analyzer and a chest belt (Polar Electro OY, Kempele, FIN) to assure time alignment of all data. **Results** Comparing lap times of the trail run, the first lap (20:11±01:58 min:s) was completed faster than the second one (21:30±01:57 min:s; p<0.01). In the up- and downhill sections, the athletes ran with 79±2% and 72±4% of VO<sub>2</sub>max while heart rate was about 93±2% and 92±2% of HRmax, respectively. ANOVA with repeated measure revealed a significant difference between the up- and downhill sections in the first and second lap respectively for oxygen uptake (both p<0.01), energy expenditure (p=0.04, p=0.03), oxygen pulse (both p=0.02) and running velocity (both p<0.01). In contrast, heart rate (p=0.32, p=0.27), ventilation (p=0.26, p=0.24) and breathing frequency (p=0.67, p=0.61) remained unaffected by running up- and downhill. **Discussion & Conclusion** While oxygen uptake and energy expenditure varied widely with each up- and downhill section, heart rate did not reflect the changing metabolic demand. Therefore, heart rate during trail running does not seem to provide an adequate measure to describe exercise intensities in undulating terrain and with variations in track surface.

## Mini-Orals

### MO-PM41 Training and Testing: Endurance & Clinical

#### VALIDATION OF A SINGLE BLOOD LACTATE MEASURE AS A PRACTICAL ALTERNATIVE TO FIXED BLOOD LACTATE THRESHOLDS IN ATHLETES

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**Introduction** Duggan and Tebbutt (1990) proposed a submaximal running test to assess aerobic capacity by a single blood lactate concentration (BLC) value measured at a fixed running speed of 12 km/h (BLC12) as a practical alternative to fixed blood lactate concentration (FBLC) determination in soldiers. To date, there are no other published data about the validity of this test. The majority of the recreational athletes do not have the opportunity to determine their FBLC thresholds (Denadai et al., 2005). It was therefore deemed necessary to further explore the appropriateness of a single BLC measure to monitor aerobic capacity in athletes. **Methods** One hundred amateur Basque-ball and thirty six professional team-sport players performed a submaximal discontinuous incremental running test. BLC was measured after every exercise stage and running speeds at FBLC of 3 mmol/L (S3mM) and 4 mmol/L (S4mM) were calculated. Regressions equations to predict S3mM and S4mM from BLC12 were determined. Eighty athletes were tested again after two months of intensified training to verify whether regression equations were valid for longitudinal monitoring of aerobic capacity. A subset of 30 subjects was tested again at least one year apart, and these data was used for external validation of the regression equations. **Results** BLC12 was significantly (p < 0.001) and inversely related to S3mM (r = 0.94) and S4mM (r = 0.98). Relationships were maintained over the longitudinal testing. Furthermore, training-induced changes in FBLC were related to changes in BLC12 (r = -0.68 to -0.83; p < 0.001). In the cross-validation study sample, estimated and measured FBLC thresholds did not differ (p > 0.05), were robustly correlated (r = 0.91-0.99; p < 0.001) and showed good agreement by Bland and Altman plots. **Discussion** BLC12 during a submaximal incremental running test in the field was strongly related to FBLC thresholds in 136 athletes. External validation of the regression equations and the maintenance of the relationships over the time despite improvements in aerobic conditioning further corroborated these results. The current study extends earlier findings (Duggan and Tebbutt, 1990) and gives empirical support to use a single BLC measure during a submaximal test of no longer than 13 min as a simple, low-cost and practical alternative to FBLC thresholds in amateur and professional athletes. This information would be of particular interest to athletes and coaches with limited resources. **References** Denadai BS, Gomide EB, Greco CC (2005). *J Strength Cond Res*, 19, 364-368 Duggan A, Tebbutt SD (1990). *Int J Sports Med*, 11, 111-115 Contact ibai.garcia.tabar@gmail.com

#### PHYSIOLOGICAL CHARACTERISTICS AND PERFORMANCE ANALYSIS OF MONZA-RESEGONE NIGHT-RUN ATHLETES

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**OBJECTIVE** Monza-Resegone night run consists in a distance of around 42 km and takes place in all weather conditions. The race is timed and the winner is the team (3 athletes) that runs in the shortest time ever. The start is in the city of Monza (162m). Competitors challenge along the flat asphalt of Monza-Brianza province until Calolziocorte where they find the first steep steps. At Erve the road ends and the run continues on uneven and dark footpath. Athletes reach the finish line (1173m) on Resegone Mount. **METHODS** The objective of this study is to describe the physiological characteristics of runners in order to assess the performance and to quantify the metabolic energy contributions in this kind of competition. Three, well-trained, male runners (58,7±6,2 kg, 167±2,2 cm, 38±4 years of age) completed an

incremental VO<sub>2</sub>max test (13 km/h 0.5% gradient start + 1.5 km/h each minute) on a treadmill. Ventilatory Threshold has been calculated using V-Slope graph (Cosmed @ Quark B2) The performance of the three men's team was investigated during the 53rd race edition, using a Garmin GPS device, with post-hoc analysis developed using Trainingpeaks Software @ with dedicated tools. RPE data has been reordered according to 0-10 Borg Scale. RESULTS VO<sub>2</sub>max (75.7±2.1 ml/min/kg) and Threshold Speed (19,0±0,6 Km/h) was comparable with medium-high level non professional runners. The first section with little elevation gain (36,3 km with 200 m of altitude gain) have the best, steady, aerobic decoupling (pace vs heart rate) with an average pace of 3:52 min/km, 15,49 km/h of average speed. In the uphill section, about 5,7 Km long, the runners average 593m of total ascent with non-linear pace and several interval efforts on steady ramps walking on hard slopes in the final part of the ascent. The mean normalized grade pace of the trail run was 7:39 min/km, corresponding to 7,8 km/h, with a running pace that shows large differences caused by different slopes and terrains. There was not a significant difference in RPE when comparing participants, with a very hard perception of the final effort at night (5.5±1 in the linear road section vs 9.2±0.5 in the uphill off-road section). CONCLUSION It's evident that Monza-Resegone is a demanding event; the performance is characterized by night running, continuum between the marathon and trail sections and the steep arrival at the top of Resegone Mount. More studies are needed to determine the impact of different aspects on this unique event, such as muscular and biomechanical aspects of the first and last part of the race and strategies for energy supplies. REFERENCES -www.alpinistimonzese.it -Padulo J, Powell D, Milia R, Ardigo LP. A paradigm of uphill running. PLoS One, 2013 vol. 8(7). CONTACT daniele\_zaccaria@virgilio.it

### DOES SELF-STRUCTURED RUNNING IMPROVE RUNNING ECONOMY AND VO<sub>2</sub>MAX IN NOVICE RUNNERS; A 31-WEEK PROSPECTIVE STUDY.

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The purpose of the study was to investigate if training volume and intensity were associated with changes in running economy (RE) and change in maximal oxygen uptake (VO<sub>2</sub>max) following self-structured running. A sample of 48 novice runners (20 females/28 males, 32.2 ±SD 7.9 years, BMI 24.2 ±SD 2.8 Kg / m<sup>2</sup>) were included in a prospective study with a 31-week follow-up. During follow-up, all subjects quantified their running volume and intensity by GPS. To examine the associations between cumulative running volume or intensity of training and changes in RE and VO<sub>2</sub>max, crude and adjusted regression analyses were performed on subjects dichotomized into low- and high-training groups. The results of the study show that the high-volume group (mean weekly running of 4.7km) had a significant improvement of 4.1% (95% CI: [1.7%; 6.3%], p=0.002) in VO<sub>2</sub>max while no change was found in the low-volume group. There was no association between intensity in training and the development in VO<sub>2</sub>max. In addition, no associations between running volume or running intensity and the development in RE were found. In conclusion novice runners with a high volume had a mean improvement in VO<sub>2</sub>max of 4.1% following a self-structured 31-week running regimen. In contrast, no change in RE was found.

### A NEW TREADMILL TEST TO EVALUATE AEROBIC INDICES FROM UPHILL RUNNING

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**Introduction** Although the popularity of uphill running and orienteering events is growing, the testing procedures applied to uphill running is limited to incremental tests at selected inclines. A clear limitation relevant to these protocols is that the runner always performs an incremental speed test against a fixed incline (Paavolainen et al., 2000; Pringle et al., 2002; Carter & Deckerle 2013). Thus, the aim of this study was to determine the aerobic functional indices from an incline-incremented treadmill test, and compare this to the indices derived from a traditional speed-incremented running test. **Methods** Thirteen endurance-trained runners took part in this study. Firstly, they performed an incremental test at 1% incline on a treadmill. This test started at 10 km/h and every 3 min the speed was increased by 1 km/h. A second incremental test was performed and the speed was set at a constant of 50% of the peak speed obtained during the first test. Additionally, the inclination started at 3 % and was incremented by 2% every 3 min. Cardiorespiratory variables were recorded during the entire testing. Blood lactate was measured after each stage. From the first test the external load (i.e. intensity) was described by speed (km/h), whilst from the latter the intensity was described by grade (%). **Results** The mean peak speed reached during the speed-based test was 17.9 ± 1.6 km/h and the peak inclination obtained during the incline-based test was 17.6 ± 1.2%. The VO<sub>2</sub>max was not significantly different between the tests. However, the maximal heart rate (HRmax) was significantly higher in the speed-based (185 bpm) than the incline-based test (181 bpm). The same was observed for heart rate at lactate turnpoints. **Discussion** The current uphill protocol seems to present greater ecological validity compared to the other protocols (Pokan et al., 1995; Paavolainen et al., 2000; Pringle et al., 2002), given that running up steep hills the speed becomes relatively slower. This situation is replicated in the present uphill test allowing runners to achieve their maximal possible inclination. The lower HRmax observed during incline-based treadmill test should be considered to prescribe uphill training according to the current protocol. This test may provide a specific basis for assessment and prescription for uphill training in orienteers and endurance runners. **References** Carter H, Deckerle J. (2013). *Science and Sport*. 28, e179-e182. Paavolainen L, Nummela A, Rusko H. (2000). *Scand J Med Sci Sports*, 10, 286-291. Pokan R, Schwabergger G, Hofmann P., Eber B, Toplak H, Gasser R, Fruhwald F, Pessenhofer H, Klein W. (1995) *Int J Sports Med*, 16, 238-242. Pringle JSM, Carter H, Doust JH, Jones AM. (2002). *Eur J Appl Physiol*, 88, 163-169. Contact: ricardo.dantas@ufsc.br

### CARDIOVASCULAR AND METABOLIC RESPONSES DURING ON-WATER UPWIND SAILING IN OPTIMIST SAILORS

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**Introduction** Physiological responses during upwind dinghy sailing have been extensively investigated in adults during simulated/on-water sailing. However, they have been only occasionally evaluated in young subjects (Callewaert et al. 2014, Rodio et al. 1999). We aimed to investigate cardiac output (CO), blood pressure and oxygen uptake (VO<sub>2</sub>) during actual on-water upwind sailing in highly trained Optimist sailors to describe cardiovascular and metabolic responses in ecological conditions. **Methods** We studied 10 highly trained male and female optimist sailors (12.7 ±0.8; 153 cm±9; 41 kg±6; sailing career: 6.2±1). In a laboratory session, VO<sub>2</sub>, cardiac output (CO), mean blood pressure (MAP) and heart rate (HR) were measured at 4 submaximal steady state workloads and at maximal level (VO<sub>2</sub>peak) on a bicycle ergometer. During on-water upwind sailing with constant course over water (C) and with tacks (T) (Lago di Garda, Italy, 20-24 °C), CO, MAP and HR were measured for 15 minutes together with boat speed and wind intensity (WI). Indirect estimation of VO<sub>2</sub>, based on HR measurements on the water and use of the individual HR-VO<sub>2</sub>ss relationship preliminarily obtained during the

laboratory session, was used. Results WI ranged between 4.6 and 13.4 m/s.  $\dot{V}O_2$  increased linearly with WI from 0.50 L/min $\pm$ 0.05 to 1.20 L/min $\pm$ 0.19. No significant difference was found between C and T.  $\dot{V}O_2$  corresponded to 48 $\pm$ 15 % $\dot{V}O_{2peak}$  at the highest WI. CO linearly increased with WI from 6.3 L/min $\pm$ 0.9 to 10 L/min $\pm$ 1.3, implying an increase of the arterial-venous O<sub>2</sub> difference by about 70 % from rest to extreme sailing conditions. MAP during sailing was a linear function of WI, ranging from 90 to about 110 mm Hg, whereas it did not change during cycling exercise. Total peripheral vascular resistances (TPR=MAP/CO) significantly decreased with WI. However, covariance analysis showed that TPR during on-water sailing was 23 % (P<0.001) larger than during cycling. Triple product of the heart (TPH = MAP \* CO) increased significantly with WI and it was about 60 % larger (P<0.001) during on-water sailing than during cycling. Discussion Optimist sailing may elicit cardiovascular and metabolic responses that may overload the heart of these young athletes. Increase of MAP and a high cardiac load may be the consequences of an increased afterload due to the (quasi-) isometric nature of prolonged hiking applied to create a counteracting up-righting moment to optimize boat speed and to prevent the boat from capsizing at the highest wind intensities. References Callewaert M, Boone J, Celie B, De Clercq D, Bourgeois JG (2014) *Pediatric Exercise Science*, 26, 56-63 Rodio A, Madaffari A, Olmeda C, Petrone D, Quattrini F (1999) *Med Sport (Roma)*. 52, 151-158.

### CRITICAL VELOCITY DOES NOT REFLECT STEADY STATE EXERCISE IN LONG TRACK SPEED SKATING

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**Introduction** The concept of critical power (CP) or critical velocity (CV) is well investigated in cycling, running and swimming, and may be used in practice to prescribe training. Exercise performed below CP/CV generally results in steady state exercise, while exercise above CP/CV results in non-steady state conditions (1). Assessment of CV requires at least three to five individual time trials, with at least five minutes between the shortest and the longest trial (1). A common event in long track speed skating is an allround tournament, 4 different time trials ranging from 500 m to 5 or 10 km, which may be used to determine CV and circumvent extensive testing. Therefore, the purpose of the current study was to determine CV and assess the physiological interpretation of the concept of CV in long track speed skating. **Methods** CV was determined from the results of an allround tournament (4 individual time trials) in 11 trained competitive speed skaters (6 male, 5 female). CV was determined using a linear model, where CV is represented by the y-intercept of the relation between  $\dot{V}O_2$  and the inverse of time to exhaustion. Subjects skated two constant velocity trials to exhaustion or 12 min, one at their individually determined CV (CV<sub>trial</sub>) and one below CV (CV-10%<sub>trial</sub>). In both constant velocity trials respiratory parameters were measured. Results Only 18% (2 out of 11) of the subjects sustained skating 12 min at CV. 7 subjects completed the CV-10%<sub>trial</sub> (64%), but did not reach steady state. RER and minute ventilation of the 7 subjects that completed the CV-10%<sub>trial</sub> increased with 11.6% and 20.3% from minute 4 to 11, respectively. Average sustainability of the CV<sub>trial</sub> and CV-10%<sub>trial</sub> were 9.3  $\pm$  2.4 min (range 5.0 min – 12 min) and 11.6  $\pm$  0.7 min (range 10.2 min – 12 min). **Discussion** Skating at CV, as calculated according to procedures described in literature, does not result in steady state exercise. It seems that even in longer skating trials the anaerobic contribution is substantial (2). This may be explained by the restricted blood flow to the upper leg muscles as a result of the characteristic crouched skating posture (3). Therefore, it is concluded that speed skating at CV does not represent the velocity that can be sustained for a considerable time and does not result in steady state exercise. **Literature** 1. Vanhatalo A, Jones AM, Burnley M. *Int J Sports Physiol Perform*. 2011;6(1):128-136. 2. de Koning JJ, Foster C, Lampen J, Hettinga F, Bobbert MF. *J Appl Physiol*. 2005;98(1):227-233. 3. Foster C, Rundell K, Snyder A, et al. *Med Sci Sports Exerc*. 1999;31(10):1433-1440. Contact r.c.m.mulder@vu.nl

### IDENTIFYING TRAINING THAT IMPROVED PERFORMANCE: ANALYSIS OF LARGE GPS TRAINING DATASETS IN WELL-TRAINED RUNNERS

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**Introduction** It is clear that the individual response to standardised training programmes is highly variable for reasons that remain unclear. An innovative approach to this problem is to examine which training gave rise to observed performance improvements. Technological developments such as portable GPS make it possible to record endurance runners' training in great detail. Consequently, the aim of the present study was to investigate which training speeds were associated with enhanced performance by examining a large training dataset of a group of runners. **Methods** All the training data from a group of 14 highly trained male endurance runners were gathered using portable GPS watches in a 1-year study by Galbraith et al. (2014). In total running speed and distance in 3,469 training sessions, accounting for 3,239 training hours were recorded by GPS with an average data resolution of less than 5 s per data point. Changes in performance were assessed with field-based trials of 1,200m, 2,400m and 3,600m conducted on an athletics track five times during the study. Runners'  $\dot{V}O_{2max}$ , OBLA, and running economy were also measured five times during the year. To analyse the 2.5 million training observations we constructed a "training distribution profile" for each session. Using the "training distribution profile" we identified the running speeds in training that were significantly associated with improvements in the runners' field based performance trials. Results Time spent training at running speeds between 5.3 and 5.7 m/s was associated significantly with increases in running performance. By constructing a model of endurance performance separate significant contributions for runners' height, OBLA and running economy to performance were also identified. A model to predict the effects on performance of time spent training at certain speeds was also developed. **Discussion** This study introduces the "training distribution profile" as a method for sports scientists to present and analyse large training datasets. The "training distribution profile" can be used to summarise continuous training data such as training speed, power output or physiological measurements such as heart rate. From an analysis of their large training dataset it was possible to determine that time spent training at 5.3 to 5.7 m/s was associated with significant improvements in running performance. For this group of runners, the identified running speeds did not correspond with velocity at  $\dot{V}O_{2max}$  or OBLA and were therefore unlikely to be identified or prescribed on the basis of current training theory. Consistent with previous studies we found that endurance running performance was associated with short stature, a high velocity at OBLA, and a high running economy. A model to predict the effect of any proposed endurance training programme on performance was also developed. Reference Galbraith, A., Hopker, J. G., Cardinale, M., Cunniffe, B., & Passfield, L. (2014). *IJSP*, 9, 1019-1025.

## INTERINDIVIDUAL VARIATION IN THE RELATIONSHIP OF DIFFERENT INTENSITY MARKERS – A CHALLENGE FOR TARGETED TRAINING PRESCRIPTIONS

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Introduction Training intensities are generally prescribed as relative intensities based on a unique reference value (e.g. VO<sub>2</sub>max) (1). However, exercise-induced physical strain is multifaceted (e.g. cardiopulmonary and metabolic) and large interindividual variability in intensity markers has been reported for constant load exercise with standardized relative intensity (2). Importantly, limited accuracy in the reference value (VO<sub>2</sub>max (2)) may contribute to variation in other intensity markers. Moreover, differences in the load dependent courses of the respective relationships are unstudied so far despite the importance of interpolated „performance curves“ for the prediction of other indicators based on the reference. This trial aims to address the above challenges in order to estimate the potential value of individualized, multivariate approaches for the prescription of exercise intensity. Methods 15 trained cyclists (VO<sub>2</sub>peak 67 ± 7 ml·kg<sup>-1</sup>·min<sup>-1</sup>) completed a stepwise incremental cycling test followed by 5 constant load tests (60 min) with the absolute workloads from the incremental test in randomized order. The highest of these workloads which yielded a lactate (BLa) steady state was repeated. From constant load tests, the courses of BLa relative to the respective reference value (e.g. %VO<sub>2</sub>peak) were interpolated by polynomial regression analogously to the lactate performance curve. Variability between individual regression curves was analyzed by mixed modeling. Due to the non-linear behavior of the BLa performance curve a polynomial (quadratic) model was employed for this dependent variable. Results The proportion of total variation in the course of BLa relative to the respective reference parameter accounted for by subject ID was 36% for %VO<sub>2</sub>peak, 51 % for %VO<sub>2</sub>reserve, 40 % for %HFmax, 44 % for HFreserve and 36 % for % of individual anaerobic threshold (IAS). The proportion of interindividual variation in the relationship of %HFmax and %VO<sub>2</sub>peak was 25 % (57 % for % of reserves). Discussion In our data, the load dependent relationship of intensity markers differs considerably between individuals. This corroborates previous reports and calls for a multivariable, individualized approach to intensity prescriptions if the aim is accurately targeting perturbations of homeostasis. However, the potential increase in accuracy and ultimately in training efficacy remains to be demonstrated. References 1. Mann T, et al. Methods of prescribing relative exercise intensity: physiological and practical considerations. *Sports Med* 2013. 2. Scharhag-Rosenberger F, et al. Exercise at given percentages of VO<sub>2</sub>max: heterogeneous metabolic responses between individuals. *J Sci Med Sport* 2010. Contact [a.hecksteden@mx.uni-saarland.de]

## HEADACHE RESPONSE TO SPECIFIC STRENGTH TRAINING FOR TENSION-TYPE HEADACHE PATIENTS IN A RANDOMIZED CONTROLLED STUDY

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Introduction Specific strength training has shown effect in reducing musculoskeletal pain in the neck. As neck pain is highly prevalent in Tension-type Headache (TTH) patients, specific strength training of the upper shoulder muscles may also be effective in TTH patients. A concern may be that high-intensity strength training worsens TTH immediately and more prolonged after training. The aim of this study was therefore to investigate the acute effect of strength training on headache intensity in the hours immediately after training. Methods 60 TTH patients were included after completion of one month headache diary, to ensure fulfillment of the ICHD2 criteria for TTH occurring ≥8 days per month. TTH patients were randomized into training and control group. The specific strength training group trained upper shoulder muscles for 10 weeks with progressive strength training 3 times weekly, using rubber bands. They also completed a 10 week training diary with TTH intensity on a numeric rating scale from 0 to 10 before, immediately after and 2 hours after training. The control group was instructed in ergonomics and posture correction. During the 10 week intervention period, and 12 weeks follow up frequency, and duration of headache were recorded in a diary. Mean values and SD are presented. Results 23 patients completed strength training, and 21 completed the control group. Specific strength training resulted in significantly lower headache duration (hours) at follow-up (227(166) compared to baseline 252(153) (p<0.05). Significantly lower frequency (days/month) at follow-up (17(10) compared to baseline 19(9) (p<0.05). Control group had also significantly lower headache duration at follow-up 144(117) compared to baseline 198(138), (p<0.05), and frequency was lower at follow-up 13(7) compared to baseline 17(7) (p<0.01). The 23 strength training patients TTH reported pain intensity before training session as 2.81(2.32), and immediately after training and 2 hours after not significantly different as 2.89 (2.26) (p= 0.07) and 2.96 (2.33) (p= 0.16), respectively. Discussion This randomized controlled trial showed significantly lower TTH duration and frequency after both strength training of upper shoulder muscles, and by the ergonomics and posture control intervention. Strength training was not superior as treatment, but was well tolerated by the TTH patients with no significant intensity increase of TTH after, or 2 hours after strength exercise. Corresponding Author: bjarne.kjeldgaard.madsen@regionh.dk

## IS THE EKBLOM-BAK TEST A VALID SCREENING TOOL FOR VO<sub>2</sub>PEAK IN HIGHLY ACTIVE INDIVIDUALS?

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Introduction Maximal oxygen consumption testing is suggested to be regularly included between training blocks of athletes in order to monitor changes in fitness throughout the season. However, despite the good reliability and validity of this physiological test, an expensive metabolic chart, and expert personnel are needed. Further, the maximal effort needed by the athlete makes this test difficult to be performed routinely. Therefore, it is important to develop valid tools that are also feasible for the estimation of the maximal oxygen consumption. The aim of this study was to validate the Ekblom-Bak test (EBT) (Ekblom-Bak et al., 2014) against an incremental test measuring peak VO<sub>2</sub> by gas exchange on a cycle ergometer in well-trained individuals. Methods 33 highly active individuals aged 34.5±6.6yrs (mean ± standard deviation (SD)) body mass 74.5±12kg, and height; 178± 9.3m) participated in the study. The EBT test was performed prior to the incremental exercise test to peak effort on a cycle ergometer for VO<sub>2</sub>peak assessment. Oxygen uptake was determined by an automated measuring system for oxygen uptake with a mixing chamber (OxygenPro, Jaeger GmbH, Germany) validated against the Douglas bag method resulting in a typical error of 2%. The mean difference and standard deviation of the differences between the EBT and measured VO<sub>2</sub>peak was calculated with Bland-Altman analysis. Results The measured mean and SD VO<sub>2</sub>peak was 4.1±0.8 L·min<sup>-1</sup> for the whole group (male 4.4±0.6 L·min<sup>-1</sup> and female 2.9±0.5 L·min<sup>-1</sup>). The mean differences between measured and estimated (EBT) VO<sub>2</sub>peak was 0.05 L·min<sup>-1</sup> (95% CI: -0.15 to 0.25). CV was 13.2% in the whole group with no significant differences between sexes. For individuals with a VO<sub>2</sub>peak within the valid range of the EBT (VO<sub>2</sub>max 1.56 to 4.49 L·min<sup>-1</sup>, n=23), the mean differences between meas-



ured and estimate  $\text{VO}_2\text{peak}$  was  $-0.22 \text{ L}\cdot\text{min}^{-1}$  (95% CI;  $-0.36$  to  $-0.08$ ), resulting in a CV of 8.2%. For individuals above the valid limit ( $n=10$ ), the mean difference was  $0.68 \text{ L}\cdot\text{min}^{-1}$  (95% CI;  $0.47$  to  $0.98$ ) with a CV of 6.9%. Discussion The Ekblom-Bak test is an easily applied and inexpensive screening tool for a population of highly active individuals within the current validity range, and may be used routinely in monitoring fitness. References Ekblom-Bak E, Björkman F, Hellenius ML, Ekblom B (2014). Scand J Med Sci Sports, 24(2), 319-326 Contact danielle.cardinale@gjh.se

### VALIDATION OF TWO SUBMAXIMAL EXERCISE TESTS IN BREAST CANCER PATIENTS UNDERGOING CHEMOTHERAPY TREATMENT

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Introduction The use of cardiopulmonary exercise testing is becoming increasingly important in disease management and in rehabilitation settings. Breast cancer patients have considerable impairments in cardiorespiratory fitness that in part have been linked to the toxic effects of anticancer therapy. Physical exercise as a means of rehabilitation of cancer patients is an emerging area of research, emphasising the need for accurate and feasible physical capacity measurements in this group. The purpose of this study was to evaluate the validity of the predicted  $\text{VO}_2\text{peak}$  from the Ekblom-Bak test (EBT) (Ekblom-Bak et al., 2014) and the Åstrand prediction model (ÅT) (Åstrand, 1960). Methods Six patients with breast cancer stage I-IIIa undergoing chemotherapy treatment (mean  $\pm$  standard deviation body mass, height, and age;  $70.68 \pm 10.25 \text{ kg}$ ;  $1.64 \pm 0.09 \text{ m}$ ; and  $51 \pm 11 \text{ yrs}$  respectively) participated in the study. Oxygen uptake was determined with a metabolic chart (OxygenPro, Jaeger GmbH, Germany) validated against the Douglas bag method (typical error=2%). EBT was performed prior to a 20 Watt incremental exercise test to peak effort on a cycle ergometer (Monark 839E, Vansbro, Sweden) for  $\text{VO}_2\text{peak}$  assessment. ÅT was used to estimate  $\text{VO}_2\text{max}$  when pedalling at 60 rpm. The mean difference and standard deviation of the differences between the EBT and ÅT and measured  $\text{VO}_2\text{peak}$  respectively was calculated with Bland-Altman analysis. Results The mean measured  $\text{VO}_2\text{peak}$  was  $1.78 \pm 0.16 \text{ L}\cdot\text{min}^{-1}$ . The predicted  $\text{VO}_2\text{peak}$  resulting from EBT led to an overestimation of  $\text{VO}_2\text{peak}$  with  $0.89 \text{ L}\cdot\text{min}^{-1}$  and a coefficient of variation of 23% while the predicted  $\text{VO}_2\text{peak}$  resulting from the ÅT led to an underestimation of  $0.41 \text{ L}\cdot\text{min}^{-1}$  with a coefficient of variation of 8% compared to the incremental exercise test to  $\text{VO}_2\text{peak}$ . Discussion The predicted  $\text{VO}_2\text{peak}$  from the Ekblom-Bak test, resulted in an overestimation of the cardiovascular fitness of the patients, suggesting that the use of this  $\text{VO}_2\text{peak}$  prediction model based on difference in heart rate between a low and high work load seems to be inappropriate in breast cancer patients undergoing chemotherapy treatment. This may be due to chemotherapy itself or medication received in combination with chemotherapy affecting the heart rate. However, from these findings, the Åstrand model resulted in a fairly good prediction of  $\text{VO}_2\text{peak}$ . This may in part be due to the fact that Åstrand prediction model is based on heart rate from one work load only. Exploration of a new correction factor may be key to improve the accuracy of submaximal testing in this population. References Astrand, I. (1960). Acta Physiol Scand Suppl, 49(169), 1-92. Ekblom-Bak E, Björkman F, Hellenius ML, Ekblom B (2014). Scand J Med Sci Sports, 24(2), 319-326 Contact sara.mijwel@ki.se

## Mini-Orals

### MO-PM42 Training and Testing: Interval training, Time trial

#### A NOVEL APPROACH TO THE PRESCRIPTION OF HIGH-INTENSITY INTERVAL TRAINING USING THE CRITICAL VELOCITY ON A YOYOIRT

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Introduction High intensity interval training (HIIT) has been shown to develop maximal oxygen uptake and enhance a players ability to undertake repeated high intensity efforts (Dupont et al., 2004). The aim of the present study was to determine the effect of YoYo IRTL1 critical velocity prescribed HIIT on performance characteristics. Methods Thirty-one sub-elite hurling players (Age:  $22 \pm 4 \text{ yrs}$ ; Height:  $178 \pm 9 \text{ cm}$ ; Weight:  $79.3 \pm 10.9 \text{ kg}$ ) participated in the study. Counter movement jump (CMJ), sprint speed (5-, 10-, 20 m), YoYo IRTL1 distance, YoYo IRTL2 distance and repeat anaerobic sprint test (RAST) performance were identified. The critical velocity on the final stage of the YoYo IRTL1 was used to calculate the distance of each players high-intensity effort. Over an eight-week period with two sessions a week a standardised step load progression (100-140%) based on the YoYo IRTL1 critical velocity was used to prescribe training. During each session multiple linear 15 seconds of effort with 15 seconds of recovery were completed. A one-way ANOVA with used to identify variation in performance characteristics with statistical significance set a  $p \leq 0.05$ . Results The CMJ, 10- and 20 m sprint performance showed little variation. The 5 m sprint performance changed significantly over the intervention period (5 m:  $1.17 \pm .08 \text{ s} - 1.04 \pm .09 \text{ s}$ ;  $p < .001$ ). Results have shown that YoYo IRTL1 distance increased by 46% ( $1424 \pm 368 \text{ m} - 2276 \pm 590 \text{ m}$ ;  $p < .001$ ) and YoYo IRTL2 distance increased by 54% ( $599 \pm 244 \text{ m} - 1045 \pm 385 \text{ m}$ ;  $p < .001$ ) respectively. The RAST performance improved over the intervention period, the change was non significant ( $p = .077$ ). Discussion The current study demonstrates that individualized HIIT induces significant improvements in 5 m, YoYoIRT L1 and L2 performance. Further research is required to identify the benefits of the current mode of exercise prescription in elite hurling players. References Dupont G, Akapo K, Berthoin S. (2004). J Strength Cond Res, 18, 584-589 Contact kieran.collins@ittdublin.ie

#### ACUTE EFFECTS OF A TRAINING SESSION ON IGF-I AND IGFBP3 CONCENTRATIONS OF JIU-JITSU FIGHTERS

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INTRODUCTION In the last few years, the literature has shown some ambiguous informations regarding the behavior of the GH/IGF-I axis during the physical effort, with some studies showing increased levels of these hormones (NEMET et al., 2012), studies failing to identify these effects (NEMET et al., 2003) and studies that found decreased levels of GH/IGF-I after training sessions (PILZ-BURSTEIN et al., 2010). On the other hand, there are few studies investigating the hormonal responses associated with the sports training in combat sports (PILZ-BURSTEIN et al., 2010). This study aimed to investigate the effects of a Jiu-Jitsu training session on the IGF-I and IGFBP-3 concentrations. METHODS Nine male jiu-jitsu fighters participated in the study, they represent the national elite in the sport in Brazil, with  $5.4 \pm 2.7$  years of practice and  $25 \pm 4.7$  years old. Blood samples were collected in the beginning of the training session (30minutes rest) and immediately

after the end of the training. Seric concentrations of IGF-1 and IGFBP3 were performed by immunocolorimetric assays (ELISA) using commercial kits (DSL, Diagnostic Systems Laboratories, USA). Wilcoxon test was used to analyze the data obtained with p values set at 0,05. RESULTS No difference was observed regarding IGF-1 ( $p= 0.57$ ) and IGFBP-3 ( $p= 0.73$ ) levels before and after the Jiu-Jitsu training session. DISCUSSION A jiu-jitsu training session composed by six fights of 7.5 minutes with perception of effort between "hard" and "very hard" did not change the IGF and IGFBP-3 concentrations. On the opposite way, the study of Nemet et al. (2002), investigating wrestling fighters before and after a training session, found reductions in total IGF-1 total ( $-11,2 \pm 2,3\%$ ) and IGF-1 bound ( $-11,2 \pm 2,4\%$ ). A possible explanation for the absence of reduced values of IGF-1 and IGFBP-3 in the second measurement in this study would be the training status of the jiu-jitsu fighters, who were in their maximum level of performance in the season. REFERENCES NEMET, D. et al. Effect of water polo practice on cytokines, growth mediators, and leukocytes in girls. *Med. Sci. Sports Exerc.*, v. 35, n. 2, p. 356-363, 2003. NEMET, D. et al. Training increases anabolic response and reduces inflammatory response to a single practice in elite male adolescent volleyball players. *J. Pediatr Endocr Met.* v. 25, n. 9-10, p. 875-880, 2012. PILZ-BURSTEIN, R. et al. Hormonal response to Taekwondo fighting simulation in elite adolescent athletes. *Eur. J. Appl. Physiol.*, v.110, p.1283-1290, 2010. CONTACT - tourinho@usp.br

## DETERMINATION OF ANAEROBIC THRESHOLD'S CORRECTION FACTORS IN DIFFERENT INTERMITTENT TRAINING SETS IN SWIMMING

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The aim of the present study was to establish correction factors and kinematic parameters in intermittent swimming bouts on maximal lactate steady state intensity. Participated in the present study, 14 swimmers affiliated to São Paulo State Aquatic Federation, with at least 3 years of competitive swimming. Intermittent swimming sessions with approximately 3000m were divided in 50, 100 and 200m bouts with 30 seconds between each bout. Lactate minimum test was used to determine anaerobic threshold intensity and performed once at each 4 weeks. The training sessions were recorded and kinematic parameters were determined in clean swimming. Normality of the data were tested through Shapiro-Wilk's test and ANOVA one-way for repeated measurements and Tukey's post-hoc was used. For the training sessions consisted of 60 bouts of 50m, 30 bouts of 100m and 14 bouts of 200m, the correction factors were  $118.11\% \pm 0.49$ ;  $105.75\% \pm 0.57$  and  $104.27\% \pm 0.62$  of the anaerobic threshold intensity and blood lactate concentrations were  $4.49 \pm 0.36$ ;  $4.01 \pm 0.37$  e  $3.32 \pm 0.53$  mM, respectively. The stroke length, stroke rate and stroke index for the 60 bouts of 50m were  $1.02 \pm 0.03$  m,  $1.24 \pm 0.05$  Hz e  $1.34 \pm 0.07$  m<sup>2</sup>/s; 30 bouts of 100m were  $0.98 \pm 0.02$  m,  $1.18 \pm 0.03$  Hz e  $1.14 \pm 0.05$  m<sup>2</sup>/s and 14 bouts of 200m were  $1.09 \pm 0.03$  m,  $1.11 \pm 0.03$  Hz e  $1.31 \pm 0.05$  m<sup>2</sup>/s, respectively, and all of them presented significant difference with the same parameters observed at anaerobic threshold intensity. Stroke length and rate presented a deflection and an inflection near each correction factor. In conclusion, intermittent training in which the objective is to improve aerobic capacity with sets of 60 bouts of 50m, 30 bouts of 100m and 14 bouts of 200m with intervals of 30 seconds, the suggested correction factors are 4.3%; 5.7% and 18% of the anaerobic threshold intensity determined by lactate minimum protocol.

## HIGH INTENSITY INTERVAL TESTING IN SPORT

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Introduction To design the training program for experienced athlete or to improve it we need to evaluate athlete. As a rule it takes a whole training session or more to obtain the complex athlete test information. Earlier we investigated the diagnostic possibilities of high-intensity interval training (HIIT) for the assessment of skiers special readiness [Shishkina et al., 2014] and were satisfied with the experimental results. The aim of new experiment was to adapt HIITesting to other kinds of sport (football, volleyball, ice hockey, etc) and to fulfill the test in field (not in laboratory) conditions. Methods Athletes performed HIITraining (Tabata Protocol) of 8 sets of 20-second interval with an "all-out" effort separated by 10 seconds of passive recovery [Tabata et al., 1996]. Heart rate (HR) monitoring with GPS (Forunner 310XT) was used to measure the distance length covered in each intensive bout in case of outdoor activity. Blood lactate and HR recovery were measured after test. For selection of HIITest activity for experienced athletes we take into account the essential competitive activity, so football players and middle distance runners did run whereas hockey players used shuttle skating. Results For analyzing the athlete conditioning we use following indicators: the best result among 8 intervals, the lowest one, the amount of 8 results as well as the speed of results decreasing in the early beginning and in the middle of the test. For example, the following distance results were obtained in hockey: 146-130-111-120-121-116-109-107. Discussion The comparison and ranking of the first distance results of all athletes of one kind of sport reveal the winner in speed and/or power while champion in 8 distances amount shows the desirable level of specific endurance. The bar chart of HIITest results assists to determine the athletes' weaknesses and motivate athlete to work harder for speed endurance in case of dramatically decrease in the first three results or to improve aerobic workability in case of uneven last three results. HR monitoring allows to determine the cardio related reasons of low athletes' results in HIITest and evaluate the cardiac "cost" of intensive physical load. Lactate measuring also help us with assessing how well-conditioned athlete is at a specific point in time or how intensive was his work during test. Thus, HIITest can be used as a specific strength and conditioning test for experienced athletes in order to lead them to an optimal performance. Test may be informative in many kinds of sport. References Tabata I, Nishimura K, Kouzaki M, Hirai Y, Ogita F, Miyachi M, Yamamoto K. (1996). *Med Sci Sports Exerc.* Oct;28(10):1327-30. Shishkina A, Tarbeeva N., Tarbeeva A. (2014). Cross-country skiing: special power+endurance HIIT- testing. ECSS: Book of Abstracts of the 19th Annual Congress of ECSS, Amsterdam. p.188. Contact sport\_tsp@mail.ru

## MONITORING FATIGUE AND RECOVERY DURING HEAVY STRENGTH TRAINING

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Introduction Lengthy periods of intensified strength training accompanied by insufficient recovery may lead to an increase of the incidence of overtraining symptoms (i.e., prolonged decline in sport-specific performance). To avoid mistakes in program design and to prevent maladaptation and underperformance, it is of great practical necessity to identify sensitive and non-extra fatigue inducing markers indicative for fatigue and recovery at an early stage. Therefore, this study aimed to investigate the sensitivity of jump tests and tensiomyography (TMG) markers of muscle contractility for monitoring fatigue and recovery. Methods Twenty-three male and female strength-power athletes ( $24.7 \pm 2.0$  yrs) completed an intensive strength training micro-cycle (STM) reflected by significant changes in discipline-

specific performance (i.e., maximal dynamic strength (1RM)). The STM comprised two straining sessions per day, morning and afternoon, and consisted of high-resistance (i.e., 85% RM) combined with maximal eccentric (i.e., 100% RM) strength exercises, both for upper and lower limbs. 1RM, countermovement jump height (CMJ), multiple rebound jump height (MRJ), reactive strength index (RSI), as well as electrostimulated (via TMG) maximal radial displacement of the muscle belly (Dm) and muscle contraction velocity (V90) were measured before (Pre), after six days of training (Post 1=fatigue) and after four days of recovery (Post 2=recovery). Magnitude-based inferences were used to determine practical significance. Results Changes in 1 RM were possibly (71.2%) decreased between Pre and Post 1 (~8%), and displayed a likely trivial (89.2%) increase between Post 1 and Post 2 (~5%). Changes in CMJ, MRJ, RSI, Dm, and V90 very likely (>95%) decreased between Pre and Post 1 (~7 to 16%), whereas only changes in CMJ and MRJ demonstrated a very likely (96.1%) or likely (80%) increase between Post 1 and Post 2 (~6%). Discussion The changes in 1RM after STM indicate a state of fatigue at Post 1 and a not fully recovered state at Post 2. The analyzed markers CMJ, MRJ, RSI, Dm, and V90 were capable to sensitively capture this fatigue at Post 1, whereby only CMJ and MRJ were eligible to sensitively monitor recovery at Post 2. In conclusion, the aforementioned markers are highly recommended to use in the field of strength training in order to improve strength training prescription, as all of these constitute to be practical and appropriate for the regular assessment of athletes' performance capacities. References Meeusen et al. (2013). *Med Sci Sports Exerc*, 45 (1), 186-205. Urhausen, A. & Kindermann, W. (2002). *Sports Med*, 32 (2), 95-102.

### PACING ACCURACY DURING AN INCREMENTAL STEP TEST IN ADOLESCENT SWIMMERS

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Introduction: Pacing strategies are attributed to optimising a balance between artefacts of fatigue and regulation of metabolism and are a function of biologically and cognitively orchestrated afferent signals. The homeostatically orientated responses are manifest to prevent a depletion of the finite anaerobic capacity. Children have an inability to modulate pace which is associated with the stage of cognitive development and lack of a perceptual template. During incremental swimming step tests the swimmer is required to exercise at pre-determined speeds thus an uncontrolled pacing strategy, would yield unreliable blood lactate (BLa) scores. Therefore the purpose of this study was to assess pacing accuracy in a group of adolescent swimmers during an incremental step test in a pool. Method: Fifteen well-trained swimmers (age  $15 \pm 1.5$ yr; height  $170.2 \pm 8.8$ cm; mass  $60.2 \pm 6.6$ kg), naïve to step testing completed two 7 x 200m tests (TR-1) and (TR-2), separated by ~72-h. They were instructed to swim to a pre-determined incrementally increasing pace based on their personal-best (PB) for 200 m per step. 5 s was added to the PB to take into account a push start, with this time equating to stage 7. All preceding stages were 5 s slower than the previous. For all swims the participants were instructed to swim an even pace, thus as swim pace increased recovery duration increased. Upon completion of each step RPE, heart rate (HR) and BLa were recorded. Results: Significant differences were observed for TR-1 between actual and prescribed swim time for step-1 ( $P=0.003$ ), step-2 ( $P=0.001$ ), step-3 ( $P=0.007$ ) and step-7 ( $P=0.002$ ) and TR-2 for step-1 ( $P=0.001$ ), step-2 ( $P=0.006$ ), step-3 ( $P=0.007$ ), step-4 ( $P=0.007$ ), step-5 ( $P=0.023$ ) and step-7 ( $P=0.02$ ). In all cases the participants swam too fast against pace in the early steps and to slow in the latter steps. Additionally significant differences were observed between the 1st and 2nd 100-m of each step in TR-1 for step 1 ( $P=0.001$ ), step 2 ( $P=0.0001$ ), step 4 ( $P=0.0001$ ), step 5 ( $P=0.005$ ), step 6 ( $P=0.0001$ ) and step 7 ( $P=0.0001$ ). Similar responses were witnessed for TR-2 ( $p<0.05$ ). Only significant difference observed between TR-1 and TR-2 for actual swim time for step 4 ( $P=0.001$ ) and step 5 ( $P=0.03$ ). Discussion: These findings suggest that the participants engaged the finite anaerobic capacity sooner than would anticipated, as a function of an inability to regulate pace. This is proposed to be a consequence of the volume of exposure to the biological and psychological sensations and cognitive developmental status. Caution should therefore be applied when using such tests with adolescent athletes and alternate means of modulating pace be investigated.

### PACING STRATEGY, MOOD AND HORMONAL RESPONSE IN YOUTH ATHLETES DURING OFFICIAL TRIATHLON AND DUATHLON COMPETITIONS

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Introduction: Given the recent introduction of the Youth Olympic games which include the sprint triathlon distance, the aim of this study was to analyze pacing, perception of effort (RPE) mood and changes in salivary cortisol (sC), and amylase (sAA) during duathlon (DUA) and triathlon (TRI) youth official competitions. Methods: Nine Youth athletes (age  $15 \pm 1$  yrs) participated in both DUA (1.8km run, 8km bike and 1km run) and TRI (300m swim, 8km bike and 2km run) national championships. A wearable GPS was used to analyse pacing. Mood, sC and sAA were measured before and after competition, and RPE, pre, post and after each segment of the race. A 2 way ANOVA was utilized to verify differences between races and on the parameter time course ( $p<0.05$ ) Results: TRI lasted  $27:17 \pm 02:17$  min:s and DUA  $27:41 \pm 01:49$  min:s. TRI showed higher RPE values 30 minutes after the race ( $4.9 \pm 1.7$ ) compared to DUA ( $2.6 \pm 1.1$ ). RPE increased during the race in TRI but not in DUA. Athletes adopted a negative pacing strategy in TRI and DUA cycling phase with a 19% and 5% velocity increase respectively. The cycling phase during TRI ( $32\text{km}\cdot\text{h}^{-1}$ ) was significantly faster than during DUA ( $31\text{km}\cdot\text{h}^{-1}$ ). No differences were observed in the POMS subscales except for tension that was significantly higher before the race in both events. sC increased significantly after DUA (157%) and TRI (145%) and remained elevated for 30 minutes. sAA increased significantly after DUA (278%) and TRI (392%) and decreased to baseline values 30 minutes post race in DUA but not in TRI. sC and sAA did not differ between events. Conclusion: The present findings indicate significant psycho-biological stress responses to DUA or TRI but no difference between competitions. sC and sAA have been used as objective markers of the hypothalamic pituitary adrenocortical axis and the sympathetic adrenomedullary system, respectively and sAA has been proven to be a sensitive marker of psychological and physical stress also during official competitions (1). As already seen in elite, youth athletes adopt a positive pacing strategy with a fast start to have an advantage during the subsequent biking phase. As previously seen during sprint triathlons (2), RPE is not reset after each transition and seems to remain a key pace regulator. TRI bike lag was faster than the DUA despite similar RPE values in the previous transition zone. Give the high performance levels obtained during the Youth Olympics, more research is necessary in this category of athletes. References 1 Piacentini et al. *JSMFP* 2015 2 Taylor et al. *Physiology and Behaviour* 2013

## INDICATORS OF PHYSICAL LOAD AND STRAIN DURING SIMULATED TIME TRIALS IN TRAINED CYCLISTS – EFFECTS OF FATIGUE STATUS AND SUBJECT IDENTITY

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**Introduction** The strain induced by exercise training is a multifaceted phenomenon comprising e.g. cardiopulmonary, metabolic and perceptual components. Current concepts for the quantification of exercise intensity are usually based on 1 reference parameter (e.g. heart rate) and assume its close association with other aspects of strain. However, large variability in the relationship of intensity markers has been reported between subjects (2) but also within the same individual in response to changes in fatigue status (1). This study aims to analyse the variability in indicators of performance and strain as well as in their relationships by repeated simulated time trials (TT) during standardized phases of rest and fatigue. **Methods** 28 well-trained cyclists (age:  $29 \pm 7$  years;  $P_{max}$ :  $323 \pm 44$  W) completed 3 TT scheduled after a 3 day resting phase (day 1), following the subsequent 6-day simulated training camp (day 8) and after a 2-day recovery phase (day 11). TT performance in W (P) was used as parameter of physical load. Blood lactate concentration (BLa), heart rate (HR) and rate of perceived exertion (RPE) indicate physical and perceived strain. Relative values (% max) were used for P and HR. The effect of fatigue status and subject identity was assessed by linear mixed modelling. Results The main effect of fatigue was highly significant ( $p < 0,001$ ) for P, HR, BLa as well as for the ratios BLa/P and RPE/P but non-significant for RPE and the the HR/P ratio. The proportion of between subject variability attributable to subject ID was 78 % for BLa, 29 % for P, 44 % for HR, 55% for RPE, 21% for HR/P, 49% for BLa/P and 51% for RPE/P. For fatigue induced changes interindividual variability accounted for 65% of total variability for BLa, 57 % for P, 41 % for HR, 56 % for RPE, 22% for HR/P, 59% for BLa/P and 53% for RPE/P. **Discussion** Fatigue impacts considerably on the magnitude and characteristic of physical strain during simulated time trials. The contribution of interindividual differences to total variation varies widely but is above 50 % in the majority of cases. Taken together these results point to a relevant degree of variability in the characteristics of physical strain between as well as within subjects. Potential practical applications of this insight range from the assessment of fatigue to the prescription and control of accurately targeted training loads. **References** 1. Lamberts RP, et al. A novel submaximal cycle test to monitor fatigue and predict cycling performance. *Br J Sports Med*, 2011. 2. Scharhag-Rosenberger F, et al. Exercise at given percentages of  $VO_{2max}$ : heterogeneous metabolic responses between individuals. *J Sci Med Sport*, 2010.

## EFFECTS OF ISCHEMIC PRECONDITIONING ON PERFORMANCE MAY BE PARTLY A PLACEBO EFFECT?

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The acute effect of ischemic preconditioning (IPC) on the maximal performance in 100-m free style swimming was studied in recreational swimmers. Fifteen swimmers ( $21.0 \pm 3.2$  yrs) participated in a random crossover model on three different days (control [CON], IPC or SHAM), separated by three to five days. IPC consisted of four cycles of 5 min occlusion (220 mmHg)/5 min reperfusion in each arm and SHAM protocol was similar to IPC, but with only 20 mmHg during the occlusion phase. After IPC, CON or SHAM the volunteers performed a maximal 100-m time-trial. IPC improved performance ( $P < 0.05$ ) in relation to the CON performance. Twelve out of 15 participants (80% of sample) improved their performance after IPC compared with CON. However, also 10 of 15 (67%) volunteers reduced 100 m time after the SHAM maneuver compared to CON, but for the whole group this improvement (0.7 sec) only showed a tendency ( $P=0.059$ ). We conclude that IPC improves maximal performance in recreational swimmers, but its increasing in performance could be partially from a placebo effect. Its effect should be test in future studies aiming to verify the real IPC effects on performance.

## Mini-Orals

### MO-SH09 Psychology III

## THE RELATIONSHIP BETWEEN SEX ROLES AND NARCISSISM AND SELF-ESTEEM IN SPORT MANAGERS

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**Introduction:** Narcissistic behaviors are pervasive in contemporary world. Hence, dominant social conditions lead to manifestation of narcissistic attributes-which is present in different people to different degrees. Many other social critics consider that masculine attributes, egocentricity, exploitativeness, megalomania, and destructiveness are interrelated (Lasch, 1984). Numerous studies have reported that the biological sex is not the only and even the most important factor in sex adjustment. The most important reason to choose that the subjects of this study from Iranian female sport manager was to study of sex roles and how these roles are realized and actualized in females who are prone to collectivist traditional values from one side and individualist modern values on the other side because of living in a developing country . **Methodology:** 147 managers participated voluntarily in this research. Personal Attribute Questionnaire was utilized to classify the subjects into women, men, women-men, and indifferent groups. To measure narcissism we used Narcissistic Personality Inventory. Self-esteem scales of Rosenberg (1965) and empathy scales of Davis (1983) were used in order to measure the adjusted function. In order to study the relation of sex roles with adjustment and narcissism, a comparison of means was made through multiple variance analysis. **Findings:** masculinity was directly related to the score of narcissistic and self-esteem scale. It had a reverse relationship with empathic concerns and personal distress. Feminist was directly related to general score of narcissistic and subscales. There was a direct relationship between feminist and empathic concerns and distress. Tukey test showed that the mean difference in self-esteem was associated with the difference of feminine-masculine and feminine means ( $F=0.42$ ,  $p < 0.01$ ). **Discussion:** exploitativeness and entitlement were not related to self-esteem, however, their unadjusted functions which were tangible in other studies, did not show in this research. The control of the effect of authority, self-sufficiency, and superiority could not show the expected reverse relationship of exploitativeness and entitlement from one side and indicators of mental health, namely self-esteem and empathy on the other side. Feminine-masculine attributes are related to adjusted-authoritative subscale and irrelevant to exploitativeness and it is healthier than masculine and feminine roles. This role has exhibited the healthiest function among the sex roles because it showed a positive correlation both with self-esteem and perspective taking but its relationship with entitlement is the reason why we cannot consider it a quite

healthy role. References: Lasch, Christopher.(1979). *The Culture of Narcissism: American Life in an Age of Diminishing Expectations*. New York, NY, USA: W. W. Norton. Rosenberg, Morris. (1965). *Society and the Adolescent Self-Image*. Princeton, NJ, USA: Princeton University Press.

### **CAREER TRANSITIONS AND OCCUPATIONAL WELL-BEING IN LEADERSHIP: THE CASE OF WOMEN AS SPORTS COACHES**

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The United Kingdom (U.K.) is working to develop the world's leading sports coaching system by 2016. However, currently women only make up 28% of the profession and very few women reach senior levels. Little is known about why career pathways are gendered or how women coaches' occupational experiences affect their health and well-being. Therefore, the aim of this study was to further understanding of the occupational health and well-being of female sports coaches and to investigate the facilitators of and barriers to their careers and life transitions. Following ethical approval from a University research ethics co-ordinator, women coaches (n = 162) based in the U.K. were recruited on a voluntary basis. Each coach completed an online version of the Shortened Stress Evaluation Tool (ASSET; Cartwright & Cooper, 2002). This questionnaire has been shown to be a valid and reliable measure of job characteristics, health, psychological well-being, and organisational commitment. Descriptive statistics were computed using a Statistical Package for the Social Sciences to provide a broad overview of the data. These statistics demonstrated that 97% of the sample categorised themselves as 'White', 'White Irish', or 'White Other,' that the number of respondents over the age of 55 (n = 6) was dramatically lower than the number of responses from younger coaches (n = 156); and that 67% of the sample was educated to undergraduate degree level or higher. Over half of the sample (53%) was employed as a head coach at the time of completion and 56% of these head coaches were employed on a part-time basis. When compared to the normative data for ASSET, our sample reported above average psychological well-being (M = 27.75, SD = 4.87), sense of purpose (M = 18.72, SD = 4.01), and engagement (M = 19.18, SD = 3.78), and reported less strain on their psychological health (M = 21.06, SD = 6.91). However, the results also demonstrate that the coaches experience poorer work-life balance (M = 13.33, SD = 5.35), job security (M = 14.20, SD = 5.39), and work relationships (M = 18.02, SD = 7.88) than the normative sample. The findings suggest that, on average, our sample of women coaches are highly engaged with their role, feel a sense of purpose during their coaching practice, and are psychologically well. The results do, however, suggest that women coaches require better work-life balance, more job security, and more meaningful relationships with their colleagues. These findings provide insight to potential facilitators of and barriers to career progression for women coaches and offer interesting applied implications for national governing bodies (NGBs). In particular, NGBs should pay acute attention to interventions that support women coaches to connect with other coaches and effectively balance their personal and occupational commitments. Cartwright, S., & Cooper, C. L. (2002). *ASSET: Management guide*. RobertsonCooper Ltd, UK.

### **DO DRIVE FOR MUSCULARITY, BODY ESTEEM, SELF-EFFICACY AND PHYSICAL ACTIVITY LEVEL DIFFER BETWEEN SELECTED AND NON-SELECTED MALE AND FEMALE CANDIDATES TO OFFICER CANDIDATE SCHOOLS?**

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Introduction: The traditional image and requirements of an ideal soldier and officer is associated with values such as physical fitness, hardiness, aggressiveness and courage. These values are considered masculine and traditionally not associated with women and femininity. Today young men and women experience extreme focus on bodily appearance and well-defined muscle tone and not necessarily physical fitness. Therefore, the aims of this paper were to examine drive for muscularity, body esteem ("physical condition"), self-efficacy and self-reported physical activity level among candidates to Officer Candidate Schools (OCS) in Norway and whether these variables differ between selected and non-selected male and female candidates. Method: Totally 1105 eligible candidates (who met at OCS-Joint Selection period in 2010) were invited to participate in this study during the three first days of the selection period. A total of 438 candidates did not participate due to early drop out, not reached, refused to participate or excluded due to duplicate/invalid ID number. Seventy percent (920 males and 131 females aged 18-30 years (median: 19 years) representing all 19 counties in Norway) were included in the study. Measurement includes both the standardized scales Drive for Muscularity Scale (DMS) and Body Esteem sub scale "Physical Condition" (BES-PC) and questions concerning self-efficacy (SE), age, height, body weight and physical activity. Results: Selected male and female candidates had significantly higher scores on the sub-scale BES-PC, the variable physical stamina, and on self-efficacy. Selected males but not females also reported significantly higher physical activity level. Selected and non-selected candidates did not differ in DMS sum scores. A significant difference was found in DMS scores between male and female candidates. Discussion and conclusion: The significant differences in "physical condition", physical stamina and self-efficacy between selected and non-selected male and female candidates are not surprising since these factors can be related to the selection criteria for both male and female candidates at OCS. However, it is of interest to further investigate whether these questionnaires alone can predict selected and not selected male and female candidates.

### **ASSOCIATIONS OF PHYSICAL ACTIVITY, CARDIORESPIRATORY FITNESS AND MOTOR SKILL TO EXECUTIVE FUNCTION: THE ACTIVE SMARTER KIDS STUDY**

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Aim: Executive functions play an important role in learning and may impact academic performance in children. Few studies have investigated the independent associations for motor skills, cardiorespiratory fitness and physical activity with executive functions in this age group [1]. The aim of this study was to examine the independent associations for motor skills, cardiorespiratory fitness and physical activity with executive functions in 10-year-old children. Methods: We included 876 children (mean (SD) age 10.2 (0.29) years, body mass index 18.1 (2.9), 49% girls) from 58 schools in Sogn and Fjordane county, Norway. Independent variables were physical activity (counts per minute measured by accelerometry), cardiorespiratory fitness (measured by the Andersen test) and a sum-score of motor skills (measured by Aiming & Catching 1 and 2 from the Movement ABC test battery (ageband 3) and the shuttle-run test and standing broad jump from the Eurofit test battery), as well as sex, age, puberty stage and body mass index. Dependent variables were several measures of executive functions (Stroop, Verbal fluency, WISC-IV (digit span) and Trail making). A linear mixed model was used to analyze the data.

Results: Motor skill was significantly associated with all measures of executive function ( $p \leq 0.008$ ). Cardiorespiratory fitness was significantly associated with Stroop, WISC-IV (digit span) and Trail making B ( $p = 0.001-0.043$ ), whereas other associations were non-significant ( $p \geq 0.852$ ). Physical activity was not associated with any measure of executive function ( $p \geq 0.060$ ). Conclusions: The present study showed that motor skill was associated with all measures of executive function in the 10-year-old children, whereas cardiorespiratory fitness were only partly-, and physical activity were not associated with executive functions. The findings supports previous studies [1] that have argued that training of motor skills are at least as important as general physical activity and increased cardiorespiratory fitness to improve cognitive function in children. Reference 1. Haapala, E.A., Cardiorespiratory Fitness and Motor Skills in Relation to Cognition and Academic Performance in Children - A Review. *Journal of Human Kinetics*, 2013. 36: p. 55-68.

### **EFFECT OF PHYSICALLY ACTIVE ACADEMIC LESSONS ON CHILDREN'S ACADEMIC ACHIEVEMENT: A RANDOMIZED CONTROLLED TRIAL**

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**Introduction** Using physical activity in the teaching of academic lesson content is a promising way of learning. Moderate to vigorous physical activity has an immediate effect as a result of elevated levels of growth factors and monoamines which were related to retention of learned material (Winter et al., 2007). Physically active academic lessons contributed positively to academic engagement (Mullender-Wijnsma et al., submitted). In the long term, regular moderate-vigorous physical activity could lead to morphological changes in the brain underlying cognitive performance (Best, 2010). The aim was to investigate the effects of a physically active academic intervention on academic achievement of primary school children. The second aim was to examine whether or not the intervention affected socially disadvantaged children (SDC) and children without this disadvantage differently. **Methods** The study is part of the randomized-controlled trial 'Fit and Academically Skilled at School' (F&S). In F&S an in-class physical activity program is implemented (Mullender-Wijnsma et al., in press). Participants were 502 children (mean age 8.0, 112 SDC) from second and third grade classes of 12 primary schools. The intervention group participated in the program for 22 weeks, three times/week for 20-30 minutes. The control group attended regular classroom lessons. In a pilot, heart rate measurements and teacher reports demonstrated that F&S was successfully implemented. Pre- and post-tests included ability scores on spelling and mathematics that were retrieved from a child academic monitoring system (CAMS). In addition, a mathematics speed test and a one-minute reading test were conducted. **Results** Multilevel analysis showed that children in the intervention group had significantly greater changes in CAMS mathematics scores (Beta=5.53,  $p < .01$ ,  $d = .55$ ) and mathematics speed test scores (Beta=3.37,  $p < .01$ ,  $d = .31$ ). No significant main effects were found on spelling and reading. A significant interaction effect was found on reading, favoring SDC (Beta=5.65,  $p < .05$ ). **Discussion** Physically active academic lessons significantly improved the mathematics achievement of primary school children. In addition, socially disadvantaged children benefited more from the intervention with regard to reading. **References** Best JR. (2010). *Dev Rev*, 30(4), 331-351. Mullender-Wijnsma MJ, Hartman E, de Greeff JW, Bosker RJ, Doolaard S & Visscher C. Submitted. Mullender-Wijnsma M J, Hartman E, De Greeff JW, Bosker RJ, Doolaard S, & Visscher C. (2015). *J School Health*, in press. Winter B, Breitenstein C, Mooren FC, Voelker K, Fobker M, Lechtermann A, et al. (2007). *Neurobiol Learn Mem*, 87, 597-609. Contact e.hartman@umcg.nl

### **PERCEIVED TEACHING CONTROL AND PSYCHOLOGICAL NEED FRUSTRATION AS PREDICTORS OF STUDENT MOTIVATION AND MOTIVATION-RELATED OUTCOMES ACROSS A SCHOOL YEAR**

Ntoumanis, N., Bartholomew, K., Mouratidis, A., Katartzi, E., Thogersen-Ntoumani, C., Vlachopoulos, S.

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**Introduction** Previous work drawing from self-determination theory (Deci & Ryan, 2000) has primarily focused on adaptive motivational teaching environments and how these support student motivation. Comparatively much less is known about the "dark motivation side" of controlling teaching environments and how these thwart student motivation. **Methods** We conducted two longitudinal studies, across a whole school year in Greek secondary education, to explore the interplay between PE students' (Mage = 14.55) perceptions of the controlling teaching environment, their experiences of psychological need frustration, and a number of motivation-related outcomes. All variables were assessed with well-validated questionnaires. **Results** Multilevel growth modeling indicated that changes in perceived teacher control related positively to changes in need frustration across the school year (studies 1 & 2) which, in turn, negatively predicted autonomous motivation and positively predicted controlled motivation and amotivation (Study 1; N = 419), and was positively related to fear of failure, contingent self-worth, and challenge avoidance in (Study 2; N = 447). Females tended to report lower levels of perceived psychological control and need frustration across both studies. In addition, students who participated in organized sport activities after school reported more autonomous motivation and contingent self-worth and less amotivation and challenge avoidance. **Discussion** These findings reinforce previous calls (e.g., Bartholomew, Ntoumanis, Ryan, Bosch, Thogersen-Ntoumani, 2011) for more research on the 'dark' motivational pathways linking maladaptive teaching environments with poor quality student motivation and related outcomes. **Practical implications** for teacher motivational environments in school physical education will be discussed. **References** Deci EL, Ryan RM (2000). *Psychological Inquiry*, 11, 227-268. Bartholomew K, Ntoumanis N, Ryan RM, Bosch J, Thogersen-Ntoumani C (2011). *Personality and Social Psychology Bulletin*, 37, 1459-1473. Contact Nikos.Ntoumanis@curtin.edu.au

### **EFFECTS OF ACUTE YOGA PRACTICE ON CARDIAC AUTONOMIC CONTROL AND STRESS RESPONSE**

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**Introduction** Psychological stress has been shown to be associated with cardiovascular disease development (Chida & Steptoe, 2010). Previous research indicated that individuals with exaggerated cardiovascular response to stress had increased risk for hypertension (Matthews et al., 2006). Most studies have investigated the effects of aerobic exercise on cardiovascular reactivity, the effects of other types of exercise, such as yoga, are undetermined. The aim of this study was to examine the effects of acute yoga practice on heart rate (HR) and cardiac autonomic control during mental stress. **Methods** 32 participants (mean age 24.75±4.10) were included in this study and completed three sessions (yoga, stationary biking SB, and video watching VW) in randomly assigned order. After each condition, participants underwent a Stroop task and mental arithmetic task, which serve as stressors. Electrocardiogram (ECG) was measured and heart rate variability (HRV) was analyzed to examine the effects of acute yoga practice on HR and HRV during mental stress. **Results** HR during SB condition was significantly higher than yoga ( $p < 0.001$ ) and VW ( $p < 0.001$ ). HR during yoga condition was also significantly higher than

VW ( $p < 0.01$ ). HR during mental stress was significantly higher after SB condition than after yoga ( $p = 0.001$ ) and VW ( $p < 0.001$ ) conditions. There was no significant difference in HR during mental stress after yoga and VW conditions. For HRV, high-frequency (HF) during SB was significantly lower than yoga ( $p < 0.001$ ) and VW ( $p < 0.001$ ). HF during mental stress was significantly lower after SB than after VW ( $p = 0.049$ ). Low-frequency (LF) during SB was significantly higher than VW ( $p = 0.027$ ). There was no significant difference in LF during mental stress after the three conditions. LF/HF during SB was significantly higher than yoga ( $p = 0.002$ ) and VW ( $p < 0.001$ ). There was no significant difference in LF/HF during mental stress after the three conditions. Discussion The results showed that HRV during mental stress was not significantly different between the three conditions, suggesting that acute yoga practice was not effective in reducing cardiovascular reactivity to mental stress. Since participants recruited for this study were healthy adults who did not have exaggerated HRV responses to stress, it may be difficult to see any significant change in HRV response after one bout of yoga in this population. Future studies may consider investigating individuals demonstrating exaggerated cardiovascular reactivity to further examine the effect of acute yoga practice on HR and HRV responses to mental stress. References Chida, Y., Steptoe, A. (2010). *Hypertension*, 55, 1026-1032. Matthews, K.A., Zhu, S., Tucker, D.C., & Whooley, M.A. (2006). *Hypertension*, 47, 391-395. Contact ihchu@kmu.edu.tw

## Mini-Orals

### MO-PM43 Training and Testing: Coordination & Agility

#### FOAM ROLLING OF THE ANKLE DORSIFLEXORS AND PLANTARFLEXORS DOES NOT AFFECT VERTICAL JUMP PERFORMANCE IN YOUNG HEALTHY ADULTS

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**Introduction** In recent years, self-myofascial release (SMR) techniques, such as foam rolling, have become a stable component of many warm-up routines [2]. Although several studies found that SMR techniques can improve range of motion [4,5], its effects on explosive force production and jumping performance are not well understood and existing research yields inconclusive results [1,3,4]. Furthermore, it is not known if different SMR protocols affect performance to the same degree. Therefore, the purpose of this study was to examine the effects of two distinctive foam rolling protocols on vertical jump performance. **Methods** 45 subjects (28 male/17 female) were randomly assigned to one of three groups. Participants in group 1 were asked to perform SMR using a foam roller of the gastroc-soleus complex (T1) while group 2 applied SMR to the tibialis anterior (T2). Group 3 served as control group (C). All groups performed a 5-minute warm-up on an elliptical trainer and were subsequently tested for their maximal CMJ height. Jump height was recorded using a GymAware Powertool that was connected via a waist belt to the participants. Retesting occurred after a 5-minute period, during which T1 and T2 applied SMR for 120 sec to the respective muscle group on each leg, while C rested. **Results** Jump height did not change significantly in any of the groups. Mean jump height of T1 increased by 0.39 cm ( $p = 0.512$ ), mean jump height of T2 decreased by 0.09 cm ( $p = 0.834$ ) and mean jump height for (C) increased by 0.51 cm ( $p = 0.104$ ). A one-way repeated measures ANOVA revealed no significant differences between groups,  $F = 0.506$  ( $p = 0.607$ ). **Discussion** The results show that foam rolling of the ankle dorsi-/ or plantarflexors has no effect on vertical jump performance in young, healthy adults. This observation is in agreement with other studies [3,4,5]. Although it has been suggested that foam rolling may have negative effects on performance [1] and should be avoided immediately before exercise, our findings do not confirm this. Our results suggest that foam rolling the lower leg muscles for up to 120 seconds does not impair explosive effort and can be used safely as part of a pre-exercise warm-up routine. **References** [1] Fama BJ, Buetti DR, (2011). Sacred Heart University. [2] Hains G, (2002). The Journal of the Canadian Chiropractic Association, 46(3), 192-200. [3] Healey KC, Hatfield DL, Blanpied P, Dorfman LR, Riebe D, (2014). *J Strength Cond Res*, 28(1), 61-8. [4] MacDonald GZ, Penney MD, Mullaley ME, Cuconato AL, Drake CD, Behm DG, Button DC, (2013). *J Strength Cond Res*, 27(3), 812-21. [5] Sullivan KM, Silvey DB, Button DC, Behm DG, (2013). *Int J Sports Phys Ther*, 8(3), 228-36. Contact felix.sempf@sport.uni-goettingen.de

#### STRENGTH AND BALANCE DEVELOPMENT IN FEMALE SOCCER PLAYERS

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**Introduction** Isokinetic testing of leg and trunk strength serves as an important means to identify muscle imbalances between both sides. Muscle imbalances are considered relevant for injury prevention and sports performance. Data on this issue in female soccer players are scarce. This study aimed at analyzing how physical strength and balance performance develop from adolescence to adulthood in female soccer players. **Methods** Forty-five female soccer players of one high-level club (under-16:  $N = 19$ ; age = 15.0 (SD 0.7) years; body mass = 54.6 (5.8) kg; body fat = 20.3 (6.8)%; under-18:  $N = 15$ ; age = 16.8 (0.6) y; body mass = 59.9 (8.0) kg; body fat = 18.4 (8.8)%; adult team (A):  $N = 11$ ; age = 21.2 (2.4) y; body mass = 61.1 (6.1) kg; body fat = 16.0 (7.8)% agreed to take part in this cross sectional study. Strength of hamstrings (H) and quadriceps (Q) muscles were measured on an isokinetic device (IsoMed 2000) at a speed of 60°/sec, 240°/sec (concentric) and -30°/sec (eccentric). H:Q-ratio was calculated for both right and left side at 60°, 240° and -30°/240°. For trunk flexion, extension and rotation, strength was measured at 60°/sec and isometric. Strength ratios between flexion/extension and left/right rotation were calculated for each group, respectively. Dynamic balance performance, assessed with the y-balance composite score, was also analyzed with respect to preferred and non-preferred kicking leg. **Results** Physical development in female soccer players from the under-16 to the adult team is mainly displayed by an increase in weight (u16: 54.6 (5.8); u18: 59.9 (8.0); A: 61.1 (6.1)), while percent body fat decreased (u16: 20.3 (6.8); u18: 18.4 (8.8), A: 16.0 (7.8)). At all speeds leg strength in the preferred kicking leg is higher in all age-categories for extension (i.e. 60°, u16: +4%; u18: +7%; A: +13%) as well as flexion (60°, u16: +10%; u18: +9%; A: +18). Strength ratio for leg flexion/extension (Croisier et al., 2003) showed also a higher ratio in the preferred kicking leg. Trunk strength values also rose with age, and ratios between isometric trunk flexion and extension developed continuously (u16: 1.59; u18: 1.68; A: 1.86). Regarding balance performance, the composite score showed no differences between groups and legs ( $p = .75$ ). **Discussion** Our results show that an unequal development in physical strength over age categories can occur in high-level female soccer players. H:Q ratios as well as the composite score showed different development in preferred and non-preferred kicking leg. If this leads to potentially harmful imbalances is questionable, but to prevent injuries and detect aberration players should attend regularly assessments. **References** Croisier, J.-L., et al. (2003). *IES* 11(1): 61-62.

### COMPARISON OF VARYING INTENSITIES ON MUSCLE ACTIVATIONS DURING BENCH PRESS IN TRAINED AND UN-TRAINED MEN

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**Introduction** Strength development and muscle hypertrophy is dependent on the type and intensity of loading as well as volume of the strength training of each individual strength athlete at a given time (Juha et al., 2003). Trained subjects have been shown to perform the same or greater number of repetitions at a given exercise intensity than untrained subjects and that this relationship is likely affected by the habitual training habits of subjects (Hoeger et al., 1990). To our knowledge, there is no study that have examined activation and fatigue of muscle, and number of repetitions that trained and untrained men could perform at 60, 80, and 90% of 1RM during bench press. Therefore, this study tested the hypothesis that activation and fatigue of muscle, and number of repetitions would significant different in trained and untrained men. **Methods** Sixteen men, 8 trained (TG) and 8 untrained (UTG), volunteered to take part in the study. TG had been undertaking a continual, resistance weight training program at least twice a week for more than 6 months using bench press exercises. UGT previously had not been involved in a formal resistance weight training program during the last year. All subjects were tested for 1RM strength, and then subjects performed maximal number of repetitions at 3 different intensities (60, 80, and 90% of 1RM) during bench press. EMG signal were recorded from the pectoralis major, deltoid anterior, and triceps brachii for maximal voluntary contraction (%MVC) and median frequency (MDF). **Results** Significant increases in %MVC for pectoralis were observed at 80% and 90% for TG compared with UTG, but significant decreases in MDF were observed at 60% and 80% for UTG compared with TG. Significant increases in %MVC for deltoid anterior and triceps brachii were observed at 80% and 90% for UTG compared with TG, but significant decreases in MDF were observed at 60% and 80% for UTG compared with TG. The changes in maximal number of repetitions were not significantly different between groups. **Discussion** Our study showed that deltoid anterior and triceps brachii in untrained and pectoralis in trained men during bench press were mainly used. However, fatigues at the selected muscles were markedly higher in untrained. Therefore, it is thought that needed to scrupulously observe the movement of protagonist, when training untrained men. **References** Ahtainen JP, Pakarinen A, Alen M, Kraemer WJ, Häkkinen K. (2003). *Eur J Appl Physiol.* 89(6):555-63. Hoeger W.W.K., Hopking D.R., Barette S.L., Hale D.F., (1990). *J Strength Cond Res.* 4(2):47-54 Shimano T, Kraemer WJ, Spiering BA, Volek JS, Hatfield DL, Silvestre R, Vingren JL, Fragala MS, Maresh CM, Fleck SJ, Newton RU, Spreuwenberg LP, Häkkinen K. (2006). *J Strength Cond Res.* 20(4):819-23. Contact [hoseh28@dankook.ac.kr]

### THE EFFECTS OF 8-WEEKS BALANCE TRAINING ON BALANCE, AGILITY AND JUMPING SKILLS OF COLLEGIATE ACTIVE FEMALE

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**Aim:** Numerous studies established relationship between balance and athletic injury but balance and athletic performance relation is less clear (Hrysomallis,2011,Tamara 2009). The purpose of this study was to investigate the effects of 8 weeks Biodex balance system training program on some selected physical and performance parameters in active healthy females. **Methods:** 44 women who study at Ankara University (mean± SD : age 20,36±1,72 yrs; height 166,13±6,31 cm; weight 56,50±10,00 kg; bmi 20,41±3,03 %; PBF 23,49±4,74 %) volunteered to participate in this study. These groups consist of physically active female and don't have ankle or knee injury. These subjects were randomly assigned to either an experimental (Exp. n=22) or a control (C. n=22) group. At the beginning of the study homogeneity of the group were determined by Mann Whitney-U . Postural stability, limits of stability, athlete single leg balance, fall risk , agility and squat jump performance were determined at the beginning of the study. The experimental group trained on the biodex balance system training program three times a week, for 8 weeks and the control groups did not practice any balance exercise during this period. **Results:** At the end of 8 weeks training with Biodex Sd system make significant changes at all balance parameters and agility performance of experimental group ( p<0.05). There is no significant difference between squat and vertical jump pre -test and post test results. **Discussion:** Balance training improved performance of selected sport-related activities and postural control measures, although it is unclear whether the effect of training would transfer to general functional enhancement. **Conclusion:** Balance training improved performance of selected sport-related activities and postural control measures, although it is unclear whether the effect of training would transfer to general functional enhancement. (Yaggie, Campbell, Brian M.,2006) **References:** 1. Hrysomallis C, Balance Ability and Athletic Performance, *Sport Medicine*, March 2011, Volume 41 Issue 3, pp 221-232 2. Tamara C. Valovich McLeod, Travis Armstrong, Mathew Miller, and Jamie L. Sauers Balance Improvements in Female High School Basketball Players After a 6-Week Neuromuscular-Training Program *Journal of Sport Rehabilitation*, 2009, 18, 465-481 © 2009 Human Kinetics, Inc. 3. Yaggie, James A.; Campbell, Brian M Effects of Balance Training on Selected Skills. *Journal of Strength & Conditioning Research*: May 2006, Volume 20 – Issue 2

### ACCELERATION, AGILITY AND CHANGE OF DIRECTION SPEED OF SUB-ELITE U-15 SOCCER PLAYERS: VARIATION BY PLAYING POSITION

Trecroci, A., Frontini, M., Millefanti, A., Alberti, G.

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**Introduction** Change of direction speed (CODS), acceleration and deceleration, combined to the technical skills are crucial qualities to elude (on offense) or to apply pressure (on defense) on opponents during a soccer match. The ability that encloses those qualities referred as agility, which is a specific key component of the soccer performance (Sheppard and Young, 2006). Since strategic factors also influence players activities (Lago-Peñas et al., 2014), it is reasonable think that agility performance may be present different characteristics within a team. In this context, the aim of this study was to assess speed, CODS and agility soccer-specific tests for positional playing and to investigate their relationship in youth sub-elite soccer players. **Methods** Thirty-three sub-elite soccer players participated in the study (mean ±SD; age: 14.5±0.5 years, weight: 52.1±9.7 kg, BMI: 19.2±1.9 kg/m<sup>2</sup>). All players had a minimum of 4 years of soccer training at baseline. Three playing positions were classified: defenders (DF, n=12), midfielders (MF, n=11) and forwards (FW, n=11). Participants were tested for 10-m sprint (acceleration), 'Modified Illinois change of direction test' (MICODT) and T-drill agility test with the addition of balls and goals (specific soccer skill). **Results** Data from the test batteries showed that FW were the fastest players in the 10-m acceleration and achieved the best performance in the MICODT and agility T-drill test compared to DF and MF. In spite of that, no statistical differences were found among playing positions (p>0.05). In addition, a moderate, but significant, correlation were found between 10-m sprint and MICODT (r = 0.63; p<0.0001), and between 10m-sprint and T-drill agility test (r = 0.52; p<0.01). **Discussion** The ability to accelerate, decel-



erate and to change directions is critical in soccer and it is considered as discriminant to predict inter-individual differences. In the MICODT test, FW tended to be faster than other roles suggesting a greater propensity in performing those patterns of movement during a soccer match (Hachana et al., 2014). However, in the present study, no differences were found in CODS ability as well as in the 10-m sprint among playing positions. T-drill agility test score also showed no significant difference in DF, MF and FW and the inconsistency of the results was probably due to the specific physical and cognitive abilities, which are widely linked among the roles. Lastly, correlations between agility and CODS with sprint performance suggest that different specific patterns of movement and physical tasks have common characters in terms of physiological and biomechanical determinants (Kutlu et al., 2012). References Hachana Y, Chaabène H, Ben Rajeb G. et al. (2014). PLoS One 9(4), e95773. Kutlu M, Yapici H, Yoncalik O, and Celik S. (2012). J Hum Kinet, 33, 143-150. Lago-Penas C, Rey E, Casais L, Gómez-López M. (2014). J Hum Kinet, 9(40),189-199. Sheppard JM, Young WB. (2006). J Sports Sci, 24(9), 919-932.

## MULTIVARIATE STATISTICAL ASSESSMENT OF PREDICTORS OF FIREFIGHTERS' MUSCULAR AND AEROBIC WORK CAPACITY

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**Introduction** Physical capacity has previously been deemed important for firefighters physical work capacity, and aerobic fitness, muscular strength, and muscular endurance are the most frequently investigated parameters of importance. Traditionally, bivariate and multivariate linear regression statistics have been used to study relationships between physical capacities and work capacities among firefighters. An alternative way to handle datasets consisting of numerous correlated variables is to use multivariate projection analyses, such as Orthogonal Projection to Latent Structures. The first aim of the present study was to evaluate the prediction and predictive power of field and laboratory tests, respectively, on firefighters' physical work capacity on selected work tasks. Also, to study if valid predictions could be achieved without anthropometric data. The second aim was to externally validate selected models. The third aim was to validate selected models on firefighters' and on civilians'. **Methods** A total of 38 (26 men and 12 women) + 90 (38 men and 52 women) subjects were included in the models and the external validation, respectively. One subject group (n = 38) performed a large battery of laboratory and field physical tests and five simulated firefighting work tasks. The other subject group (n = 90) performed simulated firefighting work tasks and a selected battery of field physical tests. Prediction and predictive power was analyzed with Orthogonal Projection to Latent Structure in SIMCA version 13.0 (MKS Umetrics AB, Umeå, Sweden) Results The best prediction (R<sup>2</sup>) and predictive power (Q<sup>2</sup>) of Carrying hose baskets up stairs, Hose pulling, Demolition, Carrying hose baskets over terrain and Victim rescue work capacities included field tests (R<sup>2</sup> = 0.73 to 0.84, Q<sup>2</sup> = 0.68 to 0.82). The best external validation was found for Carrying hose baskets up stairs work capacity (R<sup>2</sup> = 0.80) and worst for Demolition work capacity (R<sup>2</sup> = 0.40). **Discussion** The main finding in this study is that field tests can predict firefighters' physical work capacity equally well as laboratory tests and that models excluding anthropometric data are valid for prediction of physical work capacity for firefighting work tasks. Valid models were found for all simulated work tasks with all subjects included, with only firefighters included, and with only civilians included. The predictive power was satisfactory for all included work tasks except Demolition work capacity. Field physical tests valid for prediction of studied work tasks are Rowing 500 m (s), Maximal hand grip strength, (kg) Endurance bench press (n), Running 3000 m (s and s x kg<sup>-1</sup>), Barbell shoulder press endurance (n), Standing broad jump (m), Sub-maximal treadmill walking (% HR<sub>max</sub>) and Handgrip endurance. The paper has been accepted for publication in PLOS ONE

## PHYSIOLOGICAL PROFILES OF DIFFERENT COMPETITIVE LEVELS AND WEAPONS OF FENCERS

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**Introduction** Extensive studies have been done using field-based physiological tests to assess the physical fitness level among fencers of various competitive levels (Nystrom et al., 1990). However, those conducted during the past decade took no account of fencer-specific movement patterns and thus test results could not accurately reflect fencers' physical abilities. With recent availability of fencing movement specific test, speed, agility and endurance of different levels of fencers were obtained, which can be served for future benchmarking and training guide. **Methodology** Subjects: A total of 78 Hong Kong Sports Institute Scholarship fencers participated in this study. The sample included the worldcup's champion at that time. Subjects were grouped into two competitive levels: elite and sub-elite and three weapons types: epee, foil and sabre. **Study design:** Anthropometric measurements including height, weight, arm span and leg length were collected. Fitness tests including fencing-specific endurance test, maximum lunge speed and distance, 5m shuttle run and 2-4-2m shuttle run were conducted. Results Elite fencers have better anthropometric advantages compared to sub-elite fencers. Test results were reviewed against data from other countries: (a) Hong Kong (HK) fencers have a lower mean lunge speed than Greek fencers (Tsolakis and Vagenas, 2010); (b) HK fencers have a lower mean movement velocity at the same lactate concentration level than German fencers (Weichenberger et al., 2012); (c) HK male fencers have a longer mean lunge distance than Iranian male fencers Gholipour et al., 2008); (d) HK fencers scored better than Greek fencers in 5m shuttle run test (Tsolakis and Vagenas, 2010); they also scored better than British fencers in 2-4-2 m shuttle run test (Turner A, 2010). **Discussion** The study has established the first fitness database for Hong Kong fencers, which provided a solid understanding of their fitness level. It extends the scope of study on the elite fencers by providing normative data and performance standard for elite, sub-elite players with different weapons. Also, it helps coaches to optimize their training programmes and identifies talents. The data comparison against overseas fencers allows better understanding of the physical fitness of HK fencers against others. References 1. Nystrom J, Lindwall O, Ceci R, Harmenberg J, Svedenhag J, Ekblom B. (1990). Int. J. Sports Med, 11(2): 136-139. 2. Weichenberger M, Liu Y, Steinacker JM. (2012). Int. J. Sports Med, 33(1): 48-52. 3. Gholipour M, Tabrizi A, Farahmand F. (2008). W. J. Sport Sci, 2008; 1: 32-37. 4. Tsolakis C, Vagenas G. (2010). J. Hum. Kin, 23: 89-95. 5. Turner, A. (2010). Strength and conditioning for the British Fencing National Academy. London Sport Institute: London, pp. 23-24. Contact kklo@alumni.cuhk.net

## EFFECTS OF DIFFERENT PACESETTERS DURING CYCLOERGOMETER EXERCISE

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**Introduction:** Music has the capacity to generate emotions, increase work output, reduce inhibitions and encourage rhythmic movement, all of which have potential applications in sport and exercise(1). In fact, it can be applied to aerobic and anaerobic endurance performance among non-elite athletes and exercise participants with considerable ergogenic effect (2)(3). Besides acoustic, the visual stimuli also been reported to improve high intensity exercise tolerance(4). This study was aimed to assess the influence of acoustic and visual

pacesetters on the Energy Expenditure of a steady state no fatiguing exercise. Methods: Twelve healthy male subjects (age:29.3 ( $\pm$ 5.9) yrs; height:178.2 ( $\pm$ 8.1)cm; weight: 81.4 ( $\pm$ 9.1)kg) performed a 30 min long exercise at a constant speed and workload on a cycloergometer. Pedaling speed and exercise intensity were set at about 60 rpm and at a mechanical power requiring a metabolic expenditure corresponding to 70% of ventilator threshold respectively. Total Energy Expenditure (TEE) expressed as caloric equivalent for the total oxygen consumption during exercise was evaluated in 4 experimental condition: CONTROL (CON), no pacesetters; ACOUSTIC (AS), listening rhythmical acoustic stimuli at 120 beat per min; MIRROR (MS) seeing video representing an exercise performed by subject, and VISUAL (VS), seeing footage composed of two different images in a looped sequence at 120 frames per min. Results: TEE (Kcal) resulted: 549 ( $\pm$ 67) ml/kg, 536 ( $\pm$ 67); 516 ( $\pm$ 72) ml/kg; 511 ( $\pm$ 43) ml/kg in CON, AS, MS, VS respectively. In particular, it is significantly different in MS and VS compared to CON, resulting lower of an about 2%, 6 % and 7% in VS, MS and VS than CON. Discussion: Present findings show visual as well as acoustic stimuli acting as a pacesetter were able to increase performance in a 30-min steady-state aerobic exercise on cycle-ergometer. Results from this investigation could be used for the development of new training strategies, in which images projected at various frequencies can be showed to athletes to indicate the correct rhythm of the technical movement. Reference: 1) C I Karageorghis et al (1997).The psychophysical effects of music in sport and exercise: A review. *J Sport Behav*, 20: 54-68 2) C I Karageorghis et al (1996) Effect of pretest stimulative and sedative music on grip strength. *Perceptual and Motor Skill*,83, 1347-1352 3) M H Anshel et al (1978) Effects of music and rhythm on physical performance. *Research Quarterly*, 49, 109-113 4) MJ Barwood et al. (2009) A motivational music and video intervention improves high-intensity exercise performance. *J Sports Sci Med*;8: 435-442

## Mini-Orals

### MO-PM44 Training and Testing: Mixed

#### CHANGES IN PHYSICAL PERFORMANCE AND BODY COMPOSITION OF SOLDIERS DURING A 6-MONTH CRISIS MANAGEMENT OPERATION

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**Introduction** Soldiers are required to maintain a high level of physical performance in order to fulfill their duties during deployment (Nindl et al 2013). However, most available studies focusing on soldier's physical performance during military operations indicate that aerobic capacity declines with a simultaneous increase in fat mass (Nindl et al 2013, Lester et al 2010). The purpose of the present study was to investigate the changes in body composition and physical performance in male soldiers during a 6-month deployment in Lebanon. **Methods** 25 soldiers (28.9 $\pm$ 6.6 yrs., 180.1 $\pm$ 7.1 cm, 78.9 $\pm$ 8.9 kg) volunteered for the study. All measures were obtained in Lebanon. Body mass (BM), skeletal muscle mass (SMM), fat mass (FATM) and fat percentage (FAT%) were determined after an overnight fast by using segmental multi-frequency bioimpedance analysis (InBody 720, Biospace Co Ltd, Seoul, South Korea). Maximal isometric strength of extensors of the lower and upper extremities was measured in a sitting position by using a bilateral electromechanical dynamometer (Häkkinen et al 1998). Aerobic capacity was evaluated by running a 3000 meter test. The test was performed on a standardized track covered with asphalt. The soldiers were instructed to complete the test within the shortest possible time. A stopwatch was used to record the time required to run 3000 meters. **Results** The pre-post relative changes (%) and absolute means $\pm$ SDs during the study period were 0.5% (78.4 $\pm$ 8.6 vs. 78.8 $\pm$ 9.0 kg,  $p=0.39$ ) in BM, 0.5% (24.1 $\pm$ 2.5 vs 24.2 $\pm$ 2.5 kg/m<sup>2</sup>,  $p=0.41$ ) in BMI, 0.9% (39.0 $\pm$ 4.5 vs. 39.3 $\pm$ 4.7 kg,  $p=0.08$ ) in SMM, 0.1% (10.3 $\pm$ 4.8 vs. 10.3 $\pm$ 4.8 kg,  $p=0.97$ ) in FATM and -0.5% (13.0 $\pm$ 5.4 vs. 13.0 $\pm$ 5.3%,  $p=0.86$ ) in FAT%, respectively. Changes in 3000 m running test and maximal isometric strength of extensor muscles of the lower and upper extremities were 0.9% (825.7 $\pm$ 70.7 vs. 832.8 $\pm$ 83.0 s,  $p=0.46$ ), 3.2% (431.4 $\pm$ 107.0 vs. 445.2 $\pm$ 101.4 kg,  $p=0.12$ ) and -0.5% (112.9 $\pm$ 24.0 vs. 112.3 $\pm$ 22.2 kg,  $p=0.80$ ), respectively. **Discussion** The present study demonstrated that soldiers maintained their body composition and physical performance throughout the 6-month deployment. Despite the statistically non-significant changes in the mean values, large inter-individual variation was observed in all measured parameters. In conclusion, high variations highlight the need for individual training programmes and follow-up to obtain more positive changes in soldier's physical performance during deployment. **References** Nindl B, Castellani J, Warr B, et al. *Eur J Appl Physiol*. Epub 2013 Feb 22. Lester ME, Knapik JJ, et al. *Mil Med*. 2010; 175(6):417-23. Contact kai.pihlainen@mil.fi

#### A NEW ESTIMATION METHOD FOR MALE ATHLETE'S TOTAL SKELETAL MUSCLE MASS BY USING ULTRASONOGRAPHY: DIFFERENCE OF PREDICTION MODEL WITH SEDENTARY POPULATION

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**Introduction** It is important for athletes to regularly evaluate the total body skeletal muscle mass (SMM) with a simple method. A previous study (Sanada et al. (2006)) developed a prediction model of SMM for sedentary population. This prediction model only requires the measures of muscle thicknesses determined by the ultrasound, which is practical considering its portability and short-time measurement. The first purpose of this study was therefore to assess whether the previous prediction model can be applied also for young male athletes (Study 1). Next, based on the results of Study 1, we developed a new model which estimates the SMM from the ultrasound measures, specifically for the young male athletes (Study 2). **Methods** Sixty one male athletes (20.4 (0.9) yr, mean (SD)) participated in both Study 1 and 2. The subjects were randomly assigned into two groups in the Study 2; 41 subjects were involved in the development of new prediction model (Development group), and the other 20 subjects were in the validation of the new model (Validation group). In the Study 1, all subjects underwent direct measurements of SMMs by using magnetic resonance imaging (MRI). Also, sum of the nine skeletal muscle thicknesses (MTH9) was measured by B-mode ultrasound, and the measure was assigned to the previous prediction model of SMM, thus comparing the estimated SMM with that measured by the MRI. In the Study 2, for developing a new prediction model for young male athletes, a linear regression equation between the MRI-measured SMM and the MTH9 multiplied by body height in the Development group was computed. The reliability of new prediction model was validated by using the measured data (MRI and ultrasound data) in the Validation group. **Results and Discussion** In the Study 1, we found the previous prediction model was not suitable for the young male athletes, as a paired t-test showed a significant difference between the averages of predicted SMM and MRI-measured

SMM ( $P < 0.001$ ). In the Study 2, in the Validation group, there was a high correlation between the SMM estimated by our newly developed prediction model and the MRI-measured SMM ( $r = 0.96$ ,  $P < 0.05$ ), and a paired t-test showed no difference between their averages ( $P = 0.983$ ). Also, the Bland-Altman analysis did not indicate a bias in the prediction of the SMM ( $r = -0.25$ ,  $P > 0.05$ ). These results indicate the prediction model developed in this study is a reliable estimation method for SMM and an alternative to MRI measurement, in young male athletes. References Sanada K, Kearns C F, Midorikawa T, Abe T. (2006). *Eur J Appl Physiol*, 96, 24-31 Contact okoyadot@gmail.com

### **SENSIBILITY OF THE VO<sub>2</sub>PEAK AND ANAEROBIC CAPACITY TO MATURATION STAGES AND THEIR POSSIBLE RELATION WITH SWIMMING PERFORMANCE**

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Aerobic power and anaerobic capacity are two important parameters to swimming performance, and both seem to enhance with maturation. The aims of this study were to verify if aerobic power and anaerobic capacity are sensitive to maturation level, and their possible relation with performance. Thirty two swimmers (19 male and 15 female) performed one 100m, 200m, and 400m maximal effort. After the 400m, the peak oxygen uptake VO<sub>2</sub>Peak and the maximal accumulated oxygen deficit obtained in a single supramaximal exercise session (MAODRED) were determined. The VO<sub>2</sub>Peak was assessed by the backward extrapolation technique, while the MAODRED by the sum of lactic and alactic anaerobic contribution. The swimmers were divided into three groups according to pubic hair self-assessment (early-pubertal, middle-pubertal, and pubertal). The ANOVA one-way and the Pearson correlation were used to compare the values, and associate with performance, respectively. A 5% significance level was adopted. The absolute VO<sub>2</sub>Peak was higher in pubertal ( $3.85 \pm 1.12$  L•min<sup>-1</sup>) than other groups ( $2.73 \pm 0.65$  L•min<sup>-1</sup> and  $3.30 \pm 0.84$  L•min<sup>-1</sup>, for early and middle pubertal, respectively). The MAODRED was higher in pubertal ( $3.87 \pm 1.12$  L) than middle-pubertal ( $2.48 \pm 1.12$  L) and early-pubertal ( $2.10 \pm 0.90$  L), and higher in middle-pubertal than early-pubertal. Only middle-pubertal presented relation between VO<sub>2</sub>Peak and swimming performance ( $r = 0.67$  and  $0.65$  for 200m and 400m performance), while for middle-pubertal and pubertal MAODRED was significantly related with all swimming performance ( $r = 0.55$  to  $0.95$ ). In order to control gender influence on MAODRED and VO<sub>2</sub>Peak association with performance, the correlations were also performed separately (i.e. independently of biological age). No association was found for female group, while VO<sub>2</sub>Peak and MAODRED presented association with swimming performance. Moderate and strong correlations were observed when the entire groups were analyzed together (i.e. biological age and gender). Thus MAODRED is sensitive to maturation, however, VO<sub>2</sub>Peak is higher only in pubertal group. The relation of MAODRED with performance is also different between the groups and gender might influence the association of these parameters with performance. Finally the MAODRED seems to be an interesting tool to control the anaerobic capacity evolution during growth, since it increases and is associated with performance.

### **THE ACUTE EFFECTS OF DIFFERENT STRETCHING PROTOCOLS ON TAEKWONDO KICKING PERFORMANCE**

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Introduction Warm-up activity was an indispensable protocol before physical activities and sports training, especially in combat sports. Athletes will perform static stretch (SS), active stretch (AS), dynamic warm-up activities (DW), and even the pre-event working up. These activities were not appropriate for all kinds of sports events (Shrier, 2004), thus, pre-event warm-up protocols design should be event-oriented and athlete specific. Methods Nine trained taekwondo athletes were recruited in this study; all participants had to finish three pre-event warm-up protocols and kicking tests in different days with a balance design, including the dynamic warm-up activities (DW) without stretching, dynamic warm-up activities with static stretching (DWSS), and dynamic warm-up activities with active stretching (DWAS). Then following the kicking tests, the reaction time (seconds, from heel up to kick the target), normalized Rectus-femoris and Gastrocnemius muscles EMG (%MVC, maximum voluntary contraction) data were collected, repeat measures ANOVA to analyze the differences among these protocols. Results DWAS had better performance in reaction time than DWSS ( $p < 0.05$ ), but without differences compare with DW ( $0.107 \pm 0.011$ s,  $0.114 \pm 0.012$ s,  $0.110 \pm 0.009$ s, respectively). Normalized EMG of Gastrocnemius muscle in DWSS was higher than DW ( $p < 0.05$ , but without differences compare with DWAS ( $0.47 \pm 0.28$ ,  $0.31 \pm 0.26$ ,  $0.38 \pm 0.26$ , respectively). Discussion Active stretching had positive effects on acute kicking test performance; the characteristics of Taekwondo sports had higher percentage skills in lower extremity, in that, pre-event dynamic and active warm-up protocol could help athlete perform better in kicking performance. However, other research in power or sprint test did not have significant positive effects (Winchester et al., 2008), this may results from the event-oriented DWAS protocol. Active or static stretching protocol in our study did not shown significant difference in EMG, this result was similar to previous study in vertical jump performance (Unick et al., 2005). In conclusion, we suggest that dynamic and active warm-up activities had positive effects in short bout power sports. References Shrier, I. (2004). Does stretching improve performance? A systematic and critical review of the literature. *Clin J Sport Med*, 14(5), 267-273. Unick, J., Kieffer, H. S., Cheesman, W., & Feeney, A. (2005). The acute effects of static and ballistic stretching on vertical jump performance in trained women. *J Strength Cond Res*, 19(1), 206-212. Winchester, J. B., Nelson, A. G., Landin, D., Young, M. A., & Schexnayder, I. C. (2008). Static stretching impairs sprint performance in collegiate track and field athletes. *J Strength Cond Res*, 22(1), 13-19. Contact [sgucalwu@gmail.com]

### **SHOULDER STRENGTH RATIOS OF BOXER ATHLETES**

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Introduction The famous movement in boxing is the punch, with the shoulder joint and the rotators muscles playing important role (Tasiopoulos et al., 2014), which controls the twisting movements, and contributes to both mobility and stability of the joint, (Labriola et al., 2005). The aim of this study was to examine the bilateral and unilateral ratios. Methods Thirty five national men boxing athletes (age  $24.5 \pm 4.9$  yrs; height  $174 \pm 6$  cm; body weight  $76.5 \pm 11.1$  kg), participated in the present study. The evaluation of glenohumeral joint was performed using the Kin-Com<sup>TM</sup> isokinetic dynamometer, in the seated scapular plane, at  $60^\circ/s$ , and  $180^\circ/s$  angular speeds. Strength variables were peak torque (PT) of concentric (con) and eccentric (ecc) contractions, the ratios of dominant (D), non-dominant (ND), of external (ER) and internal rotators (IR). Results The PT of IRcon was from  $48.57 \pm 11.09$  to  $35.91 \pm 8.16$ Nm, the ecc from  $63.28 \pm 16.41$  to  $50 \pm 10.56$ Nm, with higher values of D ( $p = 0.003$ ,  $p = 0.001$ , respectively) than ND at  $60^\circ/s$  con and ecc, for ERcon was from  $29.11 \pm 6.5$  to  $24.88 \pm 5.1$ Nm, for ecc from  $38.37 \pm 8.94$  to  $33.82 \pm 6.91$ Nm, with  $p = 0.038$  between D and ND in ERecc at  $60^\circ/s$ . The bilateral ratios for IRcon

was  $3.41 \pm 19.97\%$ - $8.23 \pm 18.12\%$ , for ecc  $3.8 \pm 20.61\%$ - $8.63 \pm 21.06\%$ , for ERcon was  $0.39 \pm 10.51\%$ - $1.80 \pm 12.69\%$ , and ecc  $-0.54 \pm 10.93\%$ - $4.19 \pm 13.88\%$ . The unilateral ratios of con was  $61.40 \pm 13.93$ - $66.75 \pm 17.52\%$  at  $60^\circ/s$  and  $67.93 \pm 14.29$ - $71.04 \pm 14.25\%$  at  $180^\circ/s$ , with  $p=0.043$  between D and ND at  $60^\circ/s$ . Discussion The bilateral ratios for IR, ER con and ecc of D and ND, are considered normal and agree the symmetry of limbs in sports which use bilateral movements (Sakiko, 2006). The motor kinetics and the activity profile of the boxers' (Davis et al., 2013), confirm the results of the low bilateral ratios of both shoulders at  $180^\circ/s$ . The unilateral ratios at  $60^\circ/s$  have normal balance and values (Wathen, 1994), and at  $180^\circ/s$  was less higher than ordinary subjects,  $0.59$ - $0.62$ , (Shklar and Dvir, 1995) and lower than college pitchers,  $D=0.70$ ,  $ND=0.81$ , (Cook et al., 1987). References Cook EE, Gray, VL, Savinar-Nogue E, & Medeiros J (1987). Shoulder antagonistic strength ratios: a comparison between college-level baseball pitchers and nonpitchers. JOSPT, 8(9), 451-461. Davis P, Wittekind A, Beneke R (2013). Int J Sports Physiol Perform, 8(1), 84-91. Labriola JE, Lee TQ, Debski RE, McMahon PJ (2005). J Shoulder Elbow Surg, 14(1), 32S-38S. Sakiko O (2006). Master's Thesis, University of Pittsburgh. Shklar A, Dvir Z (1995). Clin Biom, 10, 369-373. Tasiopoulos I, Tripolitsioti A, Stergioulas A, Skordis, D. (2014). Shoulder isokinetic characteristics of male amateur boxers. 22nd Int Congr of Phys Educ and Sport. Wathen D (1994). Champaign, IL: Human Kinetics, In: Baechle TR (Ed). giannhstasio@yahoo.gr

### THE RELATIVE AGE EFFECT IN EUROPEAN PROFESSIONAL SOCCER: DID TEN YEARS OF RESEARCH MAKE ANY DIFFERENCE?

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The relative age effect (RAE) refers to an asymmetry in the birth-date distribution favoring players born early in the selection year and discriminating participants born later in the year. While the RAE effect was initially reported in sport more than two decades ago, there have been few attempts to examine whether player selection strategies have changed over time in light of our improved understanding of the phenomenon. We compared the birth-date distributions of professional soccer players in ten European countries over a 10-year period involving the 2000-2001 and 2010-2011 competitive seasons, respectively. Chi-square goodness-of-fit tests were used to compare differences between the observed and expected birth-date distributions across selection years. Generally, results indicated no change in the RAE over the past 10 years in professional soccer emphasizing the robust nature of this phenomenon. We propose a change in the structure of youth involvement in soccer to reduce the impact of the RAE on talent identification and selection.

### Mini-Orals

#### MO-PM29 Sports Medicine and Orthopedics: Mixed session II

### EFFECTS OF CONTRAST BATHING ON AUTONOMIC ACTIVITY

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1: Graduate School of Sport Sciences, Waseda University (Saitama, Japan), 2: Faculty of Sport Sciences, Waseda University (Saitama, Japan), 3: Waseda Institute for sport sciences, Waseda University (Saitama, Japan) Introduction Contrast bathing (CB) is a method of alternately repeating hot bathing and cold bathing for recovery in sport scenes (Hing et al., 2008). The aim of this study is to reveal the effect of CB on autonomic nervous activity by measure salivary  $\alpha$ -amylase (SAA), heart rate variability (HRV). Methods Seven healthy adult males ( $25.6 \pm 4.0$  yr) participated in this study. They performed 3 trials, which were sitting rest (REST) for 20 minutes, hot bathing (HB) at  $40^\circ\text{C}$  for 20 minutes, CB hot bathing at  $40^\circ\text{C}$  for 4 minutes and cold bathing at  $15^\circ\text{C}$  for 1 minutes 4 times repeats, and each trial was performed on different day. Saliva sampling and HRV measure were carried out before a trial (PRE), after a trial (POST), 30 minutes after a trial (POST 30), 60 minutes after a trial (POST 60). SAA concentrations were measured using enzyme linked immunosorbent assay (ELISA). We used natural logarithm of high frequency component (LnHF) of HRV as a marker of parasympathetic nervous activity and natural logarithm of low frequency / high frequency ratio (Ln(LF/HF)) of HRV as a marker of sympathetic nervous activity (Goto et al., 2010). Results In the REST ( $p < 0.05$ ) and the CB trials ( $p < 0.05$ ), SAA concentrations significantly increased at POST 60 (REST;  $43.1 \pm 31.6$  U/mL, CB;  $56.0 \pm 49.6$  U/mL) compared with PRE (rest;  $25.7 \pm 22.4$  U/mL, CB;  $41.0 \pm 38.3$  U/mL), and those were no significant change at post. In the HB trial, SAA concentration significantly increased at POST ( $54.9 \pm 43.8$  U/mL;  $p < 0.01$ ), POST 30 ( $49.2 \pm 45.7$  U/mL;  $p < 0.05$ ), POST 60 ( $51.4 \pm 43.5$  U/mL;  $p < 0.05$ ) compared with PRE ( $30.8 \pm 26.8$  U/mL). LnHF in the HB trial significantly decreased at POST ( $5.7 \pm 0.6$ ) compared with PRE ( $6.5 \pm 0.9$ ;  $p < 0.05$ ). However, LnHF in the rest and CB trials and Ln(LF/HF) in the each trials showed no significant change. Discussion In the HB trial, SAA concentration significantly increased, and LnHF significantly decreased. SAA concentration increases due to sympathetic nervous activity. Therefore, HB might activate sympathetic nerve and might depress parasympathetic nerve. On the other hand, CB might not change autonomic nervous activity. So, it is possible that CB is less stressful for athletes than HB. We conclude that CB might be better than HB for recovery after exercise. Reference Goto F, Mizutari K, Kunihiro T, Ogawa K (2010). Equilibrium Res, 69(4), 207-212. Hing WA, White SG, Bouaophone A, Lee P (2008). Phys Ther Sport, 9(3), 148-161. Contact [waseda-sp.sc@akane.waseda.jp](mailto:waseda-sp.sc@akane.waseda.jp)

### KIDNEY INJURY AND ATHLETES ANAEMIA AFTER THE SÃO PAULO INTERNATIONAL MARATHON

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The potential deleterious effects of prolonged strenuous exercise are severe dehydration, electrolyte abnormalities, rhabdomyolysis and acute myocardial infarction. However, the degree of kidney injury and the repercussions of this are not fully known. The aim of this study was to investigate kidney injury and the relationship with the athletes anaemia after the 2014 São Paulo International Marathon. Methods: 71 male marathoners, aged 24 to 54 years old were evaluated. Blood samples to analyse creatinine, haemoglobin, haematocrit, iron and bilirubin, and urine to analyse the presence of haemoglobin, protein, cylinders and leukocytes were collected 24h before, immediately after, 24h and 72h after the marathon. Results: The marathoners completed the marathon in  $282.31 \pm 52.9$  minutes. We observed an increase in iron, bilirubin and creatinine immediately and 24h after the marathon comparing with basal values. A decrease in haemoglobin and haematocrit occurred 24h and 72h after the marathon, which characterized athletes anaemia. We found protein in

14.7% and cylinders in 41.2% of the athletes. An increase in leukocytes and haemoglobin in the urine occurred, characterizing kidney injury. Nevertheless, the kidney injury markers were not correlated with the athletes anaemia markers. The increase in creatinine was correlated with the increase in leukocytes and cylinders in the urine. Conclusion: Marathon induces a reduction in haemoglobin, haematocrit and changes in kidney function. Although the marathon induces anaemia and impairment in kidney function, these two findings are not related.

### EFFECT OF SLEEP QUALITY ON COGNITIVE FUNCTION DURING EXERCISE IN ATHLETES.

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**[Introduction]** In various ball sports games, athletes are needed to cognitive executive function such as learning, attention and information processing capability, and especially during exercise. Brain activity are strongly associated with sleep, sleep deprivation decreases cognitive function. Recently, it has been reported that sleep extension improves sports performances. However, it is known that sleep is important not only time but also quality such as sleep efficiency, sleep onset latency and snooze time. Furthermore, the effect of sleep quality on cognitive function during exercise is unclear. Therefore, the aim of the present study is to examine the hypothesis that cognitive function during exercise is greater in high sleep quality. **[Methods]** Twelve female volleyball athletes ( $20 \pm 0.3$  years) were participated in this study. Sleep time and quality were measured by using NemuriSCAN (Paramountbed Co.LTD., Japan) for one week before cognitive exercise test. The subjects were divided into high sleep quality ( $n=6$ ) and low sleep quality ( $n=6$ ) groups by their median value of sleep quality. The subjects performed cognitive function using a computer-adapted Stroop Task (Simple- and Difficult-task) at rest and during aerobic bicycle exercise at 30-40% (light intensity) and 60-70% (moderate intensity) of hear rate reserve. **[Results]** Sleep quality in high sleep quality group is higher than low sleep quality group, whereas sleep time was not different between the two groups. Average response times on the simple stroop task were faster during exercise than at rest in both groups ( $P < 0.05$ ). In high sleep quality group, the difficult-task response times improved during moderate intensity exercise ( $P < 0.05$ ). The difficult-task response time in low sleep quality group did not change during both exercise intensities. **[Discussion]** The present study demonstrated that cognitive function in athletes of high sleep quality is greater during moderate intensity than athletes of low sleep quality. These results suggest that sleep quality affects sport performance during relatively heavy exercise in athletes.

### INVESTIGATION OF THE ADEQUATE METHOD OF LIQUID INTAKE FOR DOPING CONTROL 2

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**[Introduction & Purpose]** In competition, doping control might mentally and physically put stress on athletes, especially female athletes. This may cause poor condition and result in decreased performance, because they are forced to produce at least 90 ml of urine under the supervision of a witness after competition in spite of the presence of post-competition dehydration. However, little is known about the adequate method of fluid intake and the preferable type of fluid We found in our previous study that water intake at one time resulted in higher and faster urine production compared to multiple times, and that urine specific gravity can be significantly below the limit due to an increase in urine volume. The purpose of this study was to investigate the influence on urine specific gravity due to differences in the type of fluid. **[Subjects and Methods]** Sixteen female athletes 20 to 21 years (average  $20.1 \pm 0.2$ ) participated in this crossover study. After reaching 1% dehydration by exercising on a cycle ergometer, treadmill or rowing ergometer, subjects were asked to consume 800 mL of mineral water, OS-1, or POM orange. OS-1 (Otsuka Pharmaceutical Factory, Inc. Tokushima) is a hypotonic oral rehydration solution based on the guideline of American Academy of Pediatrics. OS-1 contains a moderately high amount of sodium (50 mEq/L) and 2.5% glucose to stimulate sodium and water absorption. POM orange (Ehime Drink, Ehime) is a 100% concentrated reduced juice made from mandarin orange. This juice contains 0% sodium and 10% saccharides and is hypertonic. Urine and blood samples were collected before, and at 0, 30, 60, 90, 120, 150 and 180 minutes after exercise to measure blood and urinary electrolytes. During the study, subjects were kept in an environment of controlled temperature and humidity. The data were analyzed using chi-squared test and Tukey's HSD test. **[Results]** The urine production after water consumption was statistically the highest at 90 minutes after exercise, followed by OS-1 and orange juice. The urinary specific gravity below the limit was observed the most after water consumption at 90 minutes after exercise. **[Discussion and Conclusion]** Compared with water, OS-1 consumption prevents an excessive decrease of specific gravity and maintains urine volume during the early stage. Consumption of orange juice did not result in a decreased specific gravity, however the urine volume was low during the early stage. Thus these results suggest that consumption of OS-1 might result in sufficient production of urine with adequate specific gravity.

### INVESTIGATION OF THE ADEQUATE METHOD OF LIQUID INTAKE FOR DOPING CONTROL

Etsuko, K.1, Michiko, D.1, Sachiko, Y.1, Shinya, M.1, Masaki, S.2, Yuri, M.2, Mariko, N.1, Yoko, T.1, Emi, N.1, Yasuko, I.1, Takashi, K.1

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**[Introduction & Purpose]** In competition, doping control might mentally and physically put stress on athletes, especially female athletes. This may cause poor condition and result in decreased performance, because they are forced to produce at least 90 ml of urine under the supervision of a witness after competition in spite of the presence of post-competition dehydration. However, little is known about the adequate method of fluid intake and the preferable type of fluid, and is usually decided by the coaches and athletes based on experience. The purpose of this study is to investigate the influence of the urine volume due to differences in the method of fluid intake. **[Subjects and Methods]** Fifteen female athletes 20 to 21 years (average  $21.2 \pm 0.2$ ) participated in this crossover study. After reaching 1% dehydration by exercising on a cycle ergometer, treadmill or rowing ergometer, subjects were asked to consume 800 mL of mineral water based on one of the following three patterns: 1) all at once, 2) in two portions, and 3) in four portions. Urine and blood samples were collected before, and at 0, 30, 60, 90, 120, 150 and 180 minutes after exercise to measure blood and urinary electrolytes. During the study, subjects were kept in an environment of controlled temperature and humidity. The data were analyzed using chi-squared test and Tukey's HSD test. **[Results]** The highest and fastest urine production was statistically significant at 60 minutes after exercise under pattern 1. The urinary specific gravity at 60 minutes under pattern 1 was significantly lower than under pattern 2. **[Conclusion]** Our research showed that water intake at one time was efficient to obtain sufficient urine volume. However, there is a risk that specific gravity may be significantly below

the limit due to an increase in urine volume. Therefore, to obtain both adequate urine volume and specific gravity, not only the method to intake but also type of liquid should be considered.

### THE CHALLENGES AND NEEDS FACED BY NATIONAL SWIMMING FEDERATIONS IN PROMOTING HEALTH.

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Introduction: International sport federations (IFs) and the International Olympic Committee (IOC) are increasingly concerned about developing sport worldwide. The aim of IOC Solidarity, a branch of the IOC, is to organise assistance for all National Olympic Committees (NOCs), particularly those with the greatest needs, through multi-faceted programmes. Some countries are still facing many barriers in terms of health promotion. The study "Prevalence of health promotion policies in sport clubs in Victoria, Australia" (S. J. Dobbins, J.A. Hayman, P. A. Livingstone, 2006) demonstrates that it is not just developing countries that face such barriers and finds that the main barrier in Australia is that clubs need more support from health agencies on policies. The FINA's Medical Commission's emphasis on health promotion, is reflected in the study conducted by two FINA Medical Commission members: "Sport Medicine in our national federations: The case of developing countries" (Diop M, Miller J., 2011) which suggests ways to overcome some existing barriers. Methods A multilingual survey was circulated by email and in person (at the FINA Swimming World Championships 2014 (25m) / FINA Aquatics Convention in Doha) to all 207 of the FINA NFs. The response rate was 65% (134 of the 207 NFs). The response rate among African countries was 62% (32 of the 51 African NFs replied). Results 69% of NFs reported a need for more support from the NOC, Continental or IF (training, advice, resources). In Africa that percentage increased to 78%. Also, 40% of n NFs reported a lack of health based policies and best practice guidelines. In Africa that percentage increased to 53%. Discussion NFs across the world face common barriers to health promotion. African NFs are at a disadvantage in part due to a lack of health based policies and best practice guidelines. They face many other significant barriers; therefore health promotion is not a top priority for them. Notably many NFs (62%) reported a lack of swimming facilities. In Africa this figure was 75% and it was 46% among European NFs. Conclusion Although many NFs face some common barriers to promoting health, those barriers are more significant for NFs in developing countries such as in Africa. Therefore, the means to overcome them will vary from region to region. References: Diop M, Miller J., 2011. "Sport Medicine in our national federations: The case of developing countries". [http://www.fina.org/H2O/index.php?option=com\\_content&view=article&id=2895:sports-medicine-in-our-national-federations-the-case-of-developing-countries&catid=300:articles&Itemid=974](http://www.fina.org/H2O/index.php?option=com_content&view=article&id=2895:sports-medicine-in-our-national-federations-the-case-of-developing-countries&catid=300:articles&Itemid=974) Dobbins SJ, Hayman JA, Livingstone PM. Prevalence of health promotion policies in sports clubs in Victoria, Australia. *Health Promotion Int* 2006;21:121-129. International Olympic Committee. (2013). Olympic Charter. in force as from 9 September 2013. Lausanne, Switzerland. 109 pp. International Olympic Committee. (2012). Sustainability through sport. Implementing the Olympic Movement's Agenda 21 — 2012. Lausanne, Switzerland

### INCIDENCE OF INJURIES AND ASSOCIATED FACTORS IN TRADITIONAL WRESTLING

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Introduction Traditional wrestling is considered to be cultural heritage of humanity and it should be protected. The study of injuries and their associated factors can be useful to protect traditional wrestling (for this protection) through epidemiologic studies (Yard et al., 2008; Sánchez, V et al., 2013). The aim of this study was to analyze the incidence of injuries in traditional wrestling and its risk factors in order to carry out prevention and control programs in this sport. Methods A prospective cohort study which collected injuries during the summer seasons from 2005 through 2013. The incidence rates of injuries were calculated in cases for every 1000 combats (for the entire population) and as a function of age at the start of the season, age at initiation in wrestling, regularity in combats, winner type, and weight category, respectively. At the multivariate level, a generalized linear mixed model (GLMM) was used assuming the frequency of the injuries followed a Poisson distribution. Results A total of 277 wrestlers and 336 injuries were reported in 26950 combats. The incidence was 3 injuries for every 1000 combats. The incidence of injury was significantly higher in those who did not usually participate in the league (16.0 vs 10.9; RR = 1.47; 95% CI = 1.18 to 1.83) those receiving more falls than leading to falls " (15.2 vs 10.1; RR = 1.51; 95% CI = 1.22 to 1.87) and in those who started its practice at the age of 14 (14.4 vs 9.6; RR = 1.51; 95% CI = 1.18 to 1.54). The statistical interaction between winner type and weight category implies that non-winner type wrestlers are at much higher risk of injuries than winner type wrestlers in the semi heavy (IRR: 1.89; 95%CI: [1.09, 3.28]) and heavy weight categories (IRR: 1.80; 95%CI: [1.02, 3.16]). Discussion The incidence of injuries in this traditional wrestling is consistent with that incidence expected in contact sports (Yard et al., 2008; AFHSC 2014). The non-regularity and late start in their practice are risk factors for the incidence of injuries. The technical quality is particularly relevant at heavy weights category. References Yard, E. E., Collins, C. L., Dick, R. W., & Comstock, R. D. (2008). An epidemiologic comparison of high school and college wrestling injuries. *The American journal of sports medicine*, 36(1), 57-64. Sánchez, V. M., Villa, T. F., Pérez, C. A., de la Torre, A. J. M., Robles, H. G., Álvarez, M. J. Á., & Rodríguez, M. D. (2013). A success story: New rules and fewer injuries in traditional Leonese Wrestling (2006–2012). *Apunts. Medicina de l'Esport*, 48(178), 55-61. Armed Forces Health Surveillance Center (AFHSC). (2014). Injuries associated with combat sports, active component, US Armed Forces, 2010-2013. *MSMR*, 21(5), 16.

### LIFESTYLE OF RUGBY PLAYERS IN COLOMBIA: A PILOT STUDY

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Introduction: Rugby players have already been the subject of research related to sports injuries, anthropometrics and physiological profile (Villarejo et al., 2010). However, there is a lack in studies about their lifestyle. The aim of the study was to describe Rugby player's lifestyles in Colombia and explore differences determined by sex and player's position. Methods: This is a cross-sectional study conducted on 116 rugby players from 7 cities in Colombia. Including criteria were subjects older than 18 years of age and that they practice rugby at least 12 months. All subjects fulfilled FANTASTIC questionnaire which inquired about their lifestyle (Ramírez-Vélez and Agredo, 2012). Results: From 116 rugby players, 67 (57.8%) were Backs and 49 (42.2%) were Forwards; sex distribution was 82 (70.7%) male and 34 (29.3%) female, while median age was 23 years. Median playing experience was 3 years (IQR 2-3). According FANTASTIC questionnaire, the average total score was 79.6 ± 8.9 points, while 56.6% reported a 'Good' lifestyle. There was no statistically significant difference in total score between male and female athletes (p=0, 46). However, tobacco domain score was significantly higher in women (p=0, 02).

When comparing players' position, Backs had significantly higher scores than Forwards at the average total score ( $81.2 \pm 8.9$  vs.  $77.3 \pm 8.5$   $p=0.017$ ), nutrition ( $8 \pm 2$  vs.  $6 \pm 2$   $p=0.019$ ) and personality type domains ( $6 \pm 2$  vs.  $4 \pm 2$   $p=0.001$ ). Discussion: The lower scores found in women tobacco domain are in contrast with previously published literature (Walsh et al 2012; Hessami et al. 2012.). In nutrition domain it is known that Forwards have greater weight and fat percentage than Backs (Monteiro, 2008). Regarding the type of personality, our study confirmed findings of Robazza and Bortoli, (2007), showing that Rugby players have a tendency to experience symptoms of anger. Although our study has the limitations of a pilot study, it suggests the domains where it should be intervene primarily so that studied population improve their lifestyle. References: Villarejo, D. Palao, J. Ortega, E. (2010). *Revista de ciencias del Deporte*, 6(3), 155-161 Ramírez-Velez, R. Agredo, R. (2012). *Revista Salud Pública*, 14 (2), 226-237 Walsh, J. Climstein, M. Heazlewood, I. DeBeliso, M. Kettunen, J. Sevene, T. Adams, K. (2012). *Journal of Science and Medicine in Sport* 15 S127-187 Hessami, Z. Aryanpur, M. Emami, H. Masjedi, M. (2012). *Asian Journal of Sport Medicine*, vol 3 (Number 4), 297-300 Monteiro, F. (2008). *Motricidade*, 4(3), 73-79 Robazza, C. Bortoli, L. (2007). *Psychology of Sport and Exercise*, Vol. 8 (6), 875-896 Contact: rosmaru78@hotmail.com

## SPORTS INJURIES DURING THE 2014 WORLD UNIVERSITY FLOORBALL CHAMPIONSHIP

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Introduction Floorball is a fast-paced sport with rising popularity across the world. Owing to high-intensity intermittent nature of the sport, it has been reported to present a variety of injuries. However, previous studies have been essentially season-based and injury surveillance data during international floorball tournaments is yet to be reported. This study reports prospective injury surveillance data during the 2014 World University Floorball Championship. Methods 178 male players representing 10 countries and 106 female players from six countries were observed during the championship. All the 29 men's games and 11 women's games were observed. The injury reporting system was based on that used in team sports during international tournaments. All injury documentation was done by direct on-location observation by a trained research team followed by confirmation from the team doctors or physiotherapists. Results 119 injuries during men's games and 32 injuries during women's games were documented during the tournament. Injury incidence for men and women was 4.1 and 2.9 per match and 341.7 and 241.7 per 1000 match hours respectively. Contusion was the commonest injury (~62%) followed by sprain and abrasion for both men and women athletes. Ankle was the most commonly affected part in men while it was the knee in women athletes. About 96% of injuries sustained were acute traumatic type in both men and women players. Player to player contact was the commonest cause of injury accounting for about 55% of the injuries in both men and women athletes. 75% of injuries in both men and women required medical or physiotherapeutic attention and two athletes each of men and women needed hospital transfer for specialist opinion and care. Following the injury 21 men (17.6%) and 8 women (25%) athlete could not continue in the match. Discussion International competitive floorball has a high injury incidence in both men and women categories and it was significantly higher than that reported in season-based studies. The severity of injuries in the championship was high with the majority of injured athletes requiring medical attention and a number of injured athletes being unable to continue in the game. Player contact was the commonest cause of injury during the tournament and may have an implication on game rules modification. This is apparently the first study to report the injury data during international floorball tournament. More studies are warranted to gain further insights into the cause and mechanisms of sports injuries during international floorball tournaments. References Pasanen K, Parkkari J, Kannus P et al. (2008). *Scand J Med Sci Sports*, 18, 49-54. Snellman K, Parkkari J, Kannus P et al. (2001). *Int J Sports Med*, 22, 531-536. Contact swarup.mukherjee@nie.edu.sg

## Mini-Orals

### MO-PM36 Training and Testing: Strength and neuromuscular physiology

#### PERIODIZED MAXIMUM STRENGTH AND POWER TRAINING-INDUCED CHANGES IN MUSCLE ACTIVATION LEVEL AND CONCOMITANT CHANGES IN FORCE PRODUCTION

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INTRODUCTION The interpolated twitch technique is a widely used method to determine changes in activation level (AL) of the neuromuscular system. Thus, it represents central and peripheral contributions to force production during maximal isometric contraction (MVC). However, the use of the interpolated twitch technique to distinguish training mode specific adaptations has recently been questioned (Taylor 2009). METHODS 23 healthy and physically active, but non-strength trained men performed 16 weeks of periodized strength training. The intervention included the first 4 weeks of muscle endurance (ME) training as a control period and after that the periods of maximum strength (MS)(8 wk) and power (P) training (4 wk). Training consisted of exercises for the whole body 2-3 sessions per week, but lower limbs were trained in every session. The measurements were performed at 0, 4, 12, and 16 weeks and consisted of; 1) maximum dynamic leg press strength (1RM), 2) explosive power at 60% 1RM load in leg press, 3) maximal rate of leg extension force development over the 10ms (RFD), and 4) maximum voluntary isometric knee extension using the interpolated twitch technique to the femoral nerve. RESULTS 1RM, power and RFD improved during the whole intervention ( $22 \pm 11\%$ ,  $P=0.001$ ;  $14 \pm 7\%$ ,  $P=0.001$  and  $17 \pm 39\%$ ,  $P=0.05$ ), respectively. MS training did not change AL ( $-0.8 \pm 2.5\%$ ), but during the following P training (week 12-16) AL decreased significantly ( $-2.1 \pm 3.0\%$ ,  $P=0.03$ ) with concomitant decreases in MVC ( $-7.5 \pm 13\%$ ,  $P=0.08$ ). Resting twitch-induced peak force increased during the MS training (week 4-12) compared to ME (week 0-4) ( $+13 \pm 15\%$  vs.  $-0.2 \pm 17\%$ ,  $P=0.03$ ) and P training periods ( $-5.1 \pm 13\%$ ,  $P=0.002$ ). DISCUSSION P training, after MS training mode, decreased AL, which reflects neural deficit during MVC. Electrical stimulation activates all motor units nonselectively, when P training aims to activate mainly fast ones. On the other hand, MS training improved force production capacities of peripheral components in a resting condition, which might contribute to increased muscle size. Traditionally, periodized MS and P training are associated to neural adaptations due to training (Fleck & Kraemer 1987) and in the present study they improved both dynamic and isometric fast force production. These results are in-line with previous observations, however ITT may not be the best method to characterize the extent of neural drive due to training with the intention of fast movements (Girard 2009). REFERENCES 1. Taylor J. (2009). *J Appl Physiol* 107: 354-355. 2. Fleck S and Kraemer WJ. (1987). *Designing Resistance Training*. 3. Girard O. (2009). *J Appl Physiol* 107: 359-360. heikki.peltonen@jyu.fi

## RELATIONSHIP BETWEEN MUSCLE POWER PRODUCED IN THE ACCELERATION AND THE DECELERATION PHASE OF TRUNK ROTATIONS WITH DIFFERENT WEIGHTS

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**Introduction** In sports like tennis, golf or box involving trunk rotations, high muscle force and power is produced in the acceleration phase of movement. The question remains whether the same effort is created in the deceleration phase, especially when performing with higher weights. This study investigates the associations between mean values of force, power, velocity, and torque in the acceleration and the deceleration phase of trunk rotations with different weights. **Methods** Sixty fit males (age  $21.9 \pm 3.8$  y, height  $177.5 \pm 7.7$  cm, weight  $84.7 \pm 12.3$  kg) completed two trials of trunk rotations to each direction (either from right to left or from left to right) in a standing position with a bar weight of 1, 5.5, 10.5, 15.5, and 20 kg placed on the shoulders. They were instructed to perform trunk rotations with maximal effort during both the acceleration and the deceleration phase. The FITRO Torso Dyne was used to monitor basic biomechanical parameters throughout the movement. The system consists of an inertia measurement unit in a small box with an integrated USB interface and software. While inserted on the barbell axis, the sensor unit registers instant angular of rotation movement. Calculations of force and power are based on the Newton's second law of mechanics. Force produced to accelerate and decelerate a rotation movement is obtained as a product of barbell mass and acceleration of its center of gravity (CoG). Angular acceleration is obtained by derivation of angular velocity. For the transformation of angular velocity and acceleration into their real values, a rotation radius (distance between rotation axis and barbell mass CoG) is used. Power is calculated as a product of force and velocity. **Results** Significant negative correlations ( $r$ ) were found between mean power in the acceleration and the deceleration phase of trunk rotations with weights of 1 kg ( $-0.77$ ,  $p < 0.01$ ), 5.5 kg ( $-0.78$ ,  $p < 0.01$ ), 10.5 kg ( $-0.82$ ,  $p < 0.01$ ), 15.5 kg ( $-0.90$ ,  $p < 0.01$ ), and 20 kg ( $-0.92$ ,  $p < 0.01$ ). Significant negative associations were also observed between mean force as well as mean torque in the acceleration and the deceleration phase of trunk rotations. In both cases  $r$  values ranged between  $-0.56$  ( $p < 0.05$ ) and  $-0.78$  ( $p < 0.01$ ). However, significant positive correlations ( $r$ ) were detected between mean velocity in the acceleration and the deceleration phase of trunk rotations ranging from  $+0.64$  to  $+0.84$  ( $p < 0.01$ ). **Discussion** These findings indicate that when attempting to perform a powerful rotational movement of the trunk and maximize its velocity over the entire range of motion, muscle power is not significantly different in the acceleration and the deceleration phase, regardless of weight applied. Contact zemkova@fsport.uniba.sk

## EVALUATION OF TRAINING LOAD DURING SUSPENSION TRAINING: IS SESSION-RPE A VALID METHOD?

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**Introduction** Suspension training (ST) has become a popular form of bodyweight resistance training, eliciting higher muscle activations with respect to traditional exercises secondary to muscle activity used to maintain body stability and balance (McGill et al, 2014; Snarr et al, 2014). To quantify training load, Rating of Perceived Exertion (RPE) and session-RPE (s-RPE) are widely used in sport activities. However, only a few studies have investigated the applicability of s-RPE in fitness activities (Cortis et al, 2013). Therefore, the aim of this study was to validate the use of s-RPE in ST using summated heart rate (HR) zone (Edwards-HR) as a criterion method. **Methods** Following informed consent, 8 women (age:  $30.5 \pm 11.5$  years; height:  $165.8 \pm 4.8$  cm; weight:  $59.2 \pm 3.4$  Kg; BMI:  $21.6 \pm 1.4$ ) regularly practicing ST (3 weekly sessions for previous 6 months) participated. During 6 different training sessions, s-RPE was recorded for each subject 30-min following the exercise session, and training LOAD calculated multiplying s-RPE (CR-10 scale) by training duration in minutes (Foster et al, 2001). Edwards-HR was determined using HR recorded during training and expressed as % age predicted maximal HR (HRmax). The product of accumulated training duration (minutes) in 5 HR zones by a coefficient ( $50\text{-}60\% \text{HRmax}=1$ ,  $60\text{-}70\% \text{HRmax}=2$ ,  $70\text{-}80\% \text{HRmax}=3$ ,  $80\text{-}90\% \text{HRmax}=4$ ,  $90\text{-}100\% \text{HRmax}=5$ ), was computed and summated. The relationship between s-RPE and summated HR zone was analyzed by Pearson correlation ( $p < 0.05$ ). **Results** Subjects perceived ST as hard (RPE= $5.7 \pm 1.8$ ), with high occurrence of  $\text{HR} > 70\% \text{HRmax}$  ( $72.3 \pm 9.8\% \text{HRmax}$ ). A significant ( $p=0.001$ ) very large ( $r=0.71$ ;  $R^2=0.51$ ;  $95\% \text{ CI}=0.32\text{-}0.90$ ) correlation was observed between training LOAD (s-RPE [ $222.7 \pm 73.5$  AU]) and Edwards-HR ( $109.9 \pm 32.1$  AU). **Discussion** Results suggest that ST could be classified as a moderate-to-vigorous intensity exercise according to ACSM guidelines (2014). Further, s-RPE can be used in ST to quantify training LOAD, helping the instructors evaluate training session more simply. **References** ACSM 2014, Guidelines for Exercise testing and prescription. 9th Ed. Lipincott Williams & Wilkins Cortis C et al 2013 Ital J Anat Embryol 118:64 Foster C et al 2001 J Strength Cond Res 15:109-115 McGill SM et al 2014 J Strength Cond Res 28:105-116 Snarr RL et al 2014 J Sport Human Perf 2:1-8 Contact g.giancotti@unicas.it

## MUSCULAR ACTIVITIES DURING NORMAL, SPEED, AND JUMP BASED PUSH UP EXERCISE

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Although the bench press usually requires expensive equipment, the push up can be performed anywhere (Calatayud et al., 2015). The push up is a popular exercise that is performed with the purpose of increasing and hypertrophy of upper extremity musculature (Uhl et al., 2003). Though extensive knowledge regarding push-ups performed in a dynamic regime, we know little about the same exercise when it is carried out different method. It is clear that plyometric push up provide an effective way of improving maximum force and muscular power (Vossen et al., 2000) but there has been no systematic study examining the concentric(CON) and eccentric(ECC) phase. We hypothesize that speed and jump push up exercise induces higher ECC muscleactivities than normal push up. Twenty four healthy males were randomly divided to speed push up group (spe-G  $n = 8$ ), Jump push up group (jum-G,  $n = 8$ ), or control group (nor-G,  $n=8$ ). Push up exercises performed maximum speed (spe-G), maximum jump (jum-G) and ECC (I-s) and CON (I-s) contraction (nor-G) during ECC and CON contraction. All subjects were performed one set of push up exercise to volitional repetition failure in each of the three conditions. The sEMG root mean square amplitude at first, middle, and last were recorded in the pectoralis major, triceps brachii and anterior deltoid during the push up exercise. The sEMG data were normalized to those obtained maximal voluntary contraction of each muscle (%MVC) in both ECC phase and CON phase. Compared with CON, first, middle, and last amplitude in the ECC were significantly higher muscle activities of the pectoralis major, triceps brachii, and anterior deltoid in the spe-G and jum-G. In contrast, first amplitude in the ECC were significantly lower than CON in the nor-G. It has been well-documented that eccentric contraction may elicit greater strength adaptation, muscular hypertrophy and force capabilities compared with concentric contraction (Kelly et al., 2015). In this study, we consider that speed and jump push up exercise may be effective muscle training to improving force and muscular strength, probably due to increased activity in eccentric contraction. Calatayud, J., Borreani, S., Colado, J. C., Martin, F., Tella, V., Andersen, L. L. (2015). J Strength



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### THE ANALYSIS OF YOUNG TENNIS PLAYERS UPPER EXTREMITY MUSCLE STRENGTH CONTRA-LATERAL IMBALANCE DURING A ONE YEAR STUDY

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Introduction Tennis is an asymmetric sport and it could influence young player's locomotor system evaluation. To have a success in any sport, an athlete needs to have a specific muscle strength topography, but on the other hand it's important to work with muscles not specific to tennis, to avoid a critical level of muscle strength imbalance. This question is twice as important when we speak about young tennis players, because their locomotor system is in active developing stage. The aim of the study was to evaluate contra-lateral muscles strength imbalance level in upper extremities for 11-12 years old tennis players during a one year study. Methods Shoulder, elbow and wrist joint muscle maximal isometric strength torque were measured by isokinetic device REV-9000 (Italy). Participants of the study were three right handed young tennis players (weight  $47.0 \pm 6.6$  kg, height  $164.0 \pm 6.0$  cm). The dynamics of the results were analyzed individually as well as for the entire group. Results We found contra-lateral imbalance in shoulder joint internal rotators (27%), external rotators (26%) and wrist supinators (41%). During a one year period the biggest trends in the increase of the muscle strength were observed in shoulder joint adductors (45% for right and 65% for left hand) and abductors (27% and 29%), internal (18% and 32%) and external (38% and 47%) rotators. Discussion It is verified that during a period of 11-12 years children's physiological features don't evaluate much muscle strength increasing (Degache et al., 2010). This fact allows us to assume that increase of the muscle strength could be connected with performing a regular physical exercise and tennis practice influence (Zuša et al., 2012; Saccol et al, 2010; Chandler et al, 1992). References Chandler T.J., Kibler W.B., Stracener E.C., Zeigler A.K., Pace B. Shoulder strength, power and endurance in college tennis players. Am J Sport Med, 1992, Vol. 20, 455 – 458. Degache F., Richard R., Edouard P., Oullion R., Calmels P. The relationship between muscle strength and physiological age: a cross-sectional study in boys aged from 11 to 15. Manuals of Physical and Rehabilitation Medicine, 2010, Vol. 53, 180-188. Saccol M.F., Gracitelli G.C., da Silva R.T., de Souza Laurino C.F., Fleury A.M., da Santos Andrade R. Shoulder function ratio in elite junior tennis players. Physical Therapy in Sport, 2010, Vol. 11, 8 – 11. Zuša A., Lanka J., Čupriks L. Glenohumeral joint muscle strength of the young tennis players Journal of Human Sport & Exercise, 2012. Vol.7 (1), 8 – 16. Contact anna.zusa@spa.lv

### POST-ACTIVATION POTENTIATION VS. FATIGUE USING TWO ISOMETRIC STRENGTH TRAINING PROTOCOLS: EFFECTS ON TWITCH TORQUE

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Introduction Post-Activation Potentiation (PAP), defined as an enhancement in muscle twitch properties after a conditioning contraction, gains research interest during the past years. Our knowledge and understanding on the relationship between PAP and fatigue is limited, due to lack of systematic comparisons between different conditioning stimuli in similar settings, as used in isometric strength training sessions. Limited studies have examined twitch torque during a series of isometric maximal voluntary contractions (iMVC; Hamada et al., 2003; Hicks et al., 1991; Mettler and Griffin, 2012). However, these protocols cannot be characterized as typical strength training protocols. Methods Professional male handball players (n=14) were tested for PAP before and during isometric strength training protocols, consisted of 4x6 maximal plantar flexions of 3 or 6s duration (P3 or P6, respectively) with 15s interval between repetitions and 2min between sets. Sessions were assessed in separate days, after familiarization, in random order. After warm-up, twitch torque was collected every 30s, for 5 minutes before the protocols and between repetition/set intervals, starting 2s after each iMVC. PAP was expressed as % of change relative to the values recorded before the protocols. PAP after the 1st, 6th repetition of each set, as well as the best repetition in PAP within each set were analyzed for each protocol and set, using 2-way ANOVA, with  $\alpha$  set at 0.05. Results PAP on average for all sets, was higher in P6 vs. P3 when evaluating the 1st repetition ( $78.6 \pm 7.1$  vs.  $67.8 \pm 5.2\%$ ,  $p < 0.05$ ) and in P3 vs. P6 when evaluating the last one ( $86.9 \pm 6.7$  vs.  $73.9 \pm 5.8\%$ ,  $p < 0.05$ ). When evaluating the best trial in PAP, no differences in PAP in P3 vs. P6 were observed ( $92.3 \pm 6.1$  vs.  $91.3 \pm 7.2\%$ ,  $p > 0.05$ ). For the 1st repetition P6 had more PAP compared to P3 for the sets 1 and 2. In contrast, for the 6th repetition P3 was superior to P6 in PAP for sets 3 and 4. For the best in PAP repetition, P6 and P3 showed more PAP than P3 and P6 during the first and last set, respectively. Discussion P6 shows high PAP during the first repetitions of the first 2 sets, but P3 shows milder PAP effect for a longer period along the training session. However, both protocols have on average the same potential for PAP. The clear PAP vs. fatigue interaction that we demonstrate has many implications in setting training programs and experimental designs investigating PAP. References Hamada T, Sale DG, MacDougall JD, Tarnopolsky MA (2003). Acta Physiol Scand, 178(2), 165-173. Hicks AL, Cupido CM, Martin J, Dent J (1991). Eur J Appl Physiol, 63(3-4), 278-281. Mettler JA, Griffin L (2012). Muscle Nerve, 45(3), 416-425.

### ADAPTATIONS IN MOTONEURON AND MOTOR UNIT PROPERTIES TO THE CHRONIC COMPENSATORY MUSCLE OVERLOAD

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Introduction The most prominent response to overload is muscle hypertrophy, reflected in the increase of muscle mass, cross-section area, and the increased strength. The aim of the study was to determine whether chronic muscle overload has measurable effect on electrophysiological properties of motoneurons (MNs), and the force regulation of motor units (MUs). Methods The compensatory overload was induced in the rat medial gastrocnemius (MG) by bilateral tenotomy of its synergists (lateral gastrocnemius, soleus, and plantaris); as a result, only the MG was able to evoke the foot plantar flexion. To assure regular activation of the MG muscle, rats were placed in wheel-equipped cages and subjected to a low-level treadmill exercise. Electrophysiological experiments were performed after 12 weeks of the overload, and in a control group of intact rats. Results Some of the membrane and rhythmic firing properties were considerably modified in fast-type MNs, while remained unaltered in slow-type MNs. The significant changes included a shortening of the spike rise time, an increase of the AHP amplitude, an increase of the input resistance, a decrease of the rheobase, and a decrease of the minimum current necessary to evoke steady-state firing. The data suggest higher excitability of fast-type MNs innervating the overloaded muscle, and a shift towards electrophysiological properties of slow-type MNs. MUs after overload were able to produce higher absolute tetanic

forces than under normal conditions, but achieved the same relative force level at higher frequencies than control. Increase in motoneuronal stimulation frequency in fast MUs evoked considerably higher force increase in comparison to control, while the reverse effect could be observed in slow MUs. All three MU types responded to muscle overload unequally and likely transformational changes of muscle fibers took place. Discussion The observed adaptations in mechanisms of MU force development and whole muscle force regulation coincide with altered activity of motoneurons. Adaptations in motoneuron properties have implications for the force output of fast MUs and for the recruitment process. Therefore, initial MU composition of a muscle forms a base to predict desired effects of overload, which also depend on magnitude and duration of loading and activation pattern of the involved muscle. All these relations should be considered when planning strategies for maintaining or increasing muscle mass and strength. This is important both during training and in tailored rehabilitative interventions after debilitating muscles or nerve injuries. Supported by the National Science Center grant NCN 2012/04/M/NZ4/00190. Contact krutki@awf.poznan.pl

## INVESTIGATION OF THE NEUROMUSCULAR CONTROL AND PLASTICITY OF INTRINSIC FOOT MUSCLE ACTIVATION IN HUMAN

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Introduction Effective neuromuscular control of intrinsic foot muscles is essential to stabilise the tarsal and metatarsal bones during locomotion. Nevertheless, there is little knowledge concerning their neural connectivity. Thus, this study aimed to evaluate the strength of corticospinal pathways to an intrinsic foot muscle and the potential to induce neuromuscular plasticity via electrical muscle stimulation. Methods EMG and twitch responses to peripheral nerve (PNS) and transcranial magnetic (TMS) stimulation were recorded in m. abductor hallucis (AH) of 10 healthy male volunteers (mean±SD; 29±9y; 81.3±9kg; 179±5cm). Patterns of high (100Hz) and low (20Hz) frequency low-intensity wide-pulse (1ms, WPS) electrical stimuli were delivered for 30-min to the muscle (James et al., 2012). PNS (Digitimer) of the medial plantar nerve and TMS (Magstim) of the motor cortex area related to the right-side lower limb muscles (Bowtell et al., 2013) were performed prior to, immediately and 30-min after the intervention. Stimulation intensities were optimized by constructing the input-output recruitment curves. EMG responses to multiple single pulses of suprathreshold intensity (PNS: 130%; TMS: 150%) were averaged to quantify peripheral (maximal muscle compound action potential, Mmax) and corticospinal (motor evoked potentials, MEP) excitability. Time-amplitude parameters of the twitch responses were extracted for analysis of muscle contractility. Data were expressed as relative to baseline for statistical comparisons. Results Resting AH MEP threshold was achieved at 46±10.5% (max Magstim output) and Mmax was reached at 11.6±2.3mA PNS, (200µs pulse duration). Mmax amplitude (8.3±4.1mV) remained unchanged post- and 30-min after WPS whilst an increase in excess of 10% was seen in the MEP amplitude (1.3±0.6mV) and MEP/ Mmax ratio (18±8%). WPS session reduced the twitch amplitude (4.1±1.5N) and prolonged the twitch contraction (20±20%) and relaxation (20±14%) times (all p<0.05), suggesting decreased AH contractility. Discussion The observed MEP facilitation at the background of a decreased muscle contractility imply WPS-evoked augmentation in the neural input to AH, which was maintained for at least 30-min after intervention. Enhanced excitability of corticospinal circuits suggests potential for neuroplasticity, which is likely to facilitate improved motor function. Therefore, WPS may be a useful complementary technique for strengthening of the intrinsic foot musculature via neural plasticity. Acknowledgment This study was funded by a grant from BOFAS, UK References James D, Chesters T, Sumners D, Cook D, Green D, Mileva K. Int J Sports Med 2012, 34(5): 438-43. Bowtell J, Avenell G, Hunter S, Mileva K. PLoS ONE 8(10): e77004. Contact milevkn@lsbu.ac.uk

## Mini-Orals

### MO-BN02 Coaching

#### THE EFFECTS OF TENNIS ON QUADRATUS LUMBORUM MUSCLE IN CHILDREN: A VOLUMETRIC MRI STUDY

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Introduction At a professional level, tennis induces the asymmetric hypertrophy of quadratus lumborum (QL) muscles [1]. The purpose of the present study was to assess if tennis is associated with the asymmetric hypertrophy of QL at prepubertal ages. Methods Magnetic resonance imaging (MRI) was used to determine the volume of QL in 7 male prepubescent tennis players (TP; 11.0 years) and 10 male non-active controls (11.0 years), all Tanner 1-2. The MRI images (L1-L2 intervertebral disc to pubic symphysis) were used to calculate the volume of QL. Differences between sides were assessed using Student's paired t-tests. Significant differences were assumed when P<0.05. Results In TP the volume of QL was greater in the non-dominant than in the dominant side (30.8±5.7 vs 26.2±7.0 cm<sup>3</sup>, respectively, P<0.05), whilst in control group non-dominant and dominant QL had similar volumes (26.1±5.6 vs 25.5±6.0 cm<sup>3</sup>, respectively, P=0.38). Discussion The asymmetry of QL in TP (15%) may be attributed to the forces generated to rotate and laterally flex the trunk over the non-dominant side during tennis strokes. Interestingly, in professional tennis players QL was symmetric side-to-side [1]. Trunk lateral flexion and rotation forces acting during the tennis serve are less consistent in pre-pubescent than in adolescent or adult tennis players [2]. The greater forces generated by the dominant QL during the tennis serve in adulthood might compensate the asymmetry observed in childhood [1]. In physically non-active children QL was symmetric side-to-side. In adult non-athletes non-dominant QL had 13% greater volume than dominant QL [1]. Daily living activities might increase the degree of asymmetry of QL as we age. The asymmetry of QL lead to unbalances in the forces acting on the lumbar spine which has been associated to low back pain in adulthood [3]. Conclusion Regular tennis practice at prepubertal ages induces the asymmetric hypertrophy of QL changing the pattern of hypertrophy observed in physically non-active children. Acknowledgement ULPGC2013-24 References 1. Sanchis-Moysi, J., et al., The hypertrophy of the lateral abdominal wall and quadratus lumborum is sport-specific: an MRI segmental study in professional tennis and soccer players. Sports Biomech, 2013. 12(1): p. 54-67. 2. Whiteside, D., et al., Coordination and variability in the elite female tennis serve. J Sports Sci, 2015. 33(7): p. 675-86. 3. Clark, B.C., et al., Muscle functional magnetic resonance imaging and acute low back pain: a pilot study to characterize lumbar muscle activity asymmetries and examine the effects of osteopathic manipulative treatment. Osteopath Med Prim Care, 2009. 3: p. 7.

## RELATIONSHIP BETWEEN CONTRACTION INTENSITY AND MUSCLE HARDNESS ASSESSED BY REAL-TIME TISSUE ELASTOGRAPHY FOR THE ELBOW FLEXORS AT DIFFERENT JOINT ANGLES

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**Introduction** Elastography is used to assess muscle hardness, and the relationship between muscle contraction intensity and muscle hardness has been examined. For example, Yoshitake et al. [1] reported that biceps brachii muscle hardness assessed by shear wave elastography increased linearly from 15% ( $\approx 50$  kPa) to 60% ( $\approx 200$  kPa) of the maximal voluntary contraction (MVC) strength at 90° elbow flexion. Another type of elastography known as real-time tissue elastography (RTE) has also been used to assess muscle hardness, but no previous study has investigated the relationship between muscle contraction intensity and muscle hardness at different depths of muscle using RTE. The present study investigated the effects of contraction intensity and elbow joint angle on muscle hardness of biceps brachii at different layers of the muscle using RTE. **Methods** Sixteen men performed isometric contractions of the elbow flexors at 15, 30, 45, 60% of their MVC strength at 90°, 60° and 30° elbow flexion, in this order. Up to 45 elastograph images were recorded by RTE (Prosound F75, Hitachi Aloka Medical, Japan) while gently pressing a probe attached with a reference material (acoustic coupler, 22.6 Kpa), over biceps brachii mid-belly during the middle 3 s of 5-s sustained contraction. In an image, a circular ( $\phi=5$  mm) region of interest (ROI) was set in the coupler and the muscle at every 5-mm layer from surface to deep muscle, and a large ROI ( $\phi=30-50$  mm) was also set to include whole biceps brachii. Using a built-in software, strain ratio (SR: muscle/acoustic coupler) was calculated for each image. Changes in SR from 15-60% MVC were compared between the elbow joint angles and the different depths of ROI by two-way repeated measures ANOVA. Results SR in whole muscle decreased ( $P<0.05$ ) from 15% (90°:  $0.29 \pm 0.13$ , 60°:  $0.28 \pm 0.18$ , 30°:  $0.30 \pm 0.12$ ) to 60% MVC (90°:  $0.10 \pm 0.04$ , 60°:  $0.09 \pm 0.04$ , 30°:  $0.08 \pm 0.04$ ), but no significant intensity x angle interaction effect was evident. SR of deep layers ( $>25$  mm) was low even at low intensity contractions (e.g. 30-35 mm, 15% MVC,  $0.01 \pm 0.01$ ), and did not change with increasing in the contraction intensity. **Discussion** The effect of elbow joint angle was minor for the changes in muscle hardness, and SR did not change at deeper layers of the muscle with increasing the contraction intensity for biceps brachii muscle. This may be due to the limitation of RTE (e.g. deformation does not affect deep regions). Further study is necessary to investigate region specific muscle hardness using shear wave elastography. **References** 1) Yoshitake et al. (2014) *Muscle Nerve* 50:103-113. Contact t.inami@aoni.waseda.jp

## ACUTE EFFECT OF DIFFERENT WARM-UP PROTOCOLS ON MECHANICAL PROPERTIES OF THE BICEPS BRACHII MUSCLE IN HEALTHY SUBJECTS

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**Introduction** Warm-up exercise before physical activity or sports competition is a well-accepted and recommended method to enhance sports performance and reduce the susceptibility of musculoskeletal injury (Bishop, 2002). Previous study indicated that different types of warm up exercise will affect the performance of exercise capacity (Holt et al., 2008). Most studies have investigated the effects of different types of warm up exercise on sports performance, but the change of mechanical properties of the skeletal muscle are not fully understood. The aim of this study is to examine the acute effect of different warm-up protocols on mechanical properties of the biceps brachii muscle. **Methods** Six participants (mean age  $20.7 \pm 1.0$ ) were included in this study. All participants completed three warm up sessions (general dynamic, static stretching, and whole body vibration) in randomly assigned order. Myoton Pro (Model #, Name of the company, State/Country of the company) was used to measure three mechanical properties including muscle tone (frequency), elasticity (decrement) and stiffness (stiffness) before and after each warm up session. Each subject performed three trials in a randomized, cross-over design, with trial separated by at least 1 day. **Results** After general dynamic (GD), there was no significant change on mechanical properties of the biceps muscle. After static stretching (SS), the values of frequency ( $p=0.025$ ) and stiffness ( $p=0.019$ ) were significantly decreased after intervention. On the contrary, whole body vibration (WBV) significantly increased the values of frequency ( $p=0.015$ ) and stiffness ( $p=0.009$ ). The decreasing values of frequency and stiffness in SS were significant higher than WBV ( $p=0.009$ ;  $p=0.007$ ) and GD ( $p=0.005$ ;  $p=0.024$ ). **Discussion** The results showed that static stretching (SS) was the most effective warm up method on decreasing muscle tone and stiffness. Previous studies had shown that static stretching (SS) improved muscle flexibility and preventing musculotendinous injuries, however, it also reduced the strength and power performances (Veevo et al., 2012). Further examination of muscle strength on different mechanical characteristics could be performed in future. **References** Bishop, D. (2002). *Sports Med*, 33(6), 439-454. Holt BW, Lambourne K. (2008). *J Strength Cond Res*, 22 (5), 1720-1720. Veevo M, Erelina J, Riso EM, Gapeyeva H, Pääsuke M (2012). *Acta Kinesiologiae Universitatis Tartuensis*, 18, 39-46. Contact fss2416@yahoo.com.tw, u103507006@cc.kmu.edu.tw.

## RESTING MUSCLE HARDNESS OF BICEPS BRACHII ASSESSED BY A PRESSURE METER IN COMPARISON TO REAL TIME ELASTOGRAPHY

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**Introduction** Muscle hardness is often assessed by a pressure meter (PM) that measures the force against the pressure applied to the tissue [1]. This method has revealed that muscle hardness is related to mechanical property of muscle fibers and/or muscle volume [1]. Recently, many studies use ultrasound elastography to evaluate muscle hardness [2]; however, the relationship between muscle hardness assessed by PM and elastography is not clear. The present study compared the muscle hardness measured by PM and that by real-time tissue elastography (RTE). **Methods** Resting biceps brachii muscle hardness was assessed by a pressure meter (TK-HS100, Tokushu-keisoku, Japan) and by RTE (Prosound F75 ; Hitachi Aloka Medical, Japan) for both arms of 21 young men. Each subject lay on his back on a bed relaxing his upper arm, and a PM probe was applied to the mid-belly of biceps brachii. To measure muscle hardness by PM, the displacement-force curve was divided into subcutaneous and muscle component from B-mode ultrasound images, then muscle hardness value (E) was calculated using the slope at a specific depth of the muscle component. In RTE measurement, a transducer was positioned on the mid-belly to obtain elastograph images, and several region of interest (ROI) were set in the biceps brachii, and strain ratio (SR) between the reference coupler placed on the top of the transducer and ROI was calculated ( $SR=1.0$ : the same hardness between muscle and the coupler  $<22.6$  kPa>). The relationship between E and SR was analysed by a Pearson's product moment, and several regression analyses. **Results & Discussion** Among several E values obtained, it appeared that the value at 40% of muscle thickness (E40%) was most reliable. E40% ranged from 16.3 to 65.8 kPa, and SR of the same region ranged from 0.34 to 2.35 (7.7 to 53.1 kPa). The correlation coefficient between SR and E40% was significant ( $r=-0.64$ ,  $R^2=0.40$ ,  $P<0.001$ ), but the correlation was not strong. The

relationship between SR and E40% was fitted better to an exponential curve ( $SR=26.8 \cdot E40\%^{-0.445}$ ), but the coefficient was 0.50. Other regression analyses using different E values from different depths of the muscle provided the coefficients less than -0.64. This suggests that the muscle hardness assessed by PM and RTE is different. One of the reasons for this may be the difference in the magnitude of muscle deformation during the measurement such that muscle tissue was deformed approximately 25 mm in depth for the PM measure, but was slightly deformed for the RTE measure. Reference 1) Murayama et al. (2000) *Eur J Appl Physiol* 82:361-7 2) Chino et al. (2013) *PLoS One* 7:e45764. Contact: murayama@z3.keio.jp

## COMPARISON OF MUSCLE ELASTICITY BETWEEN PASSIVE AND ACTIVE CONDITION

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**Introduction** Muscle elasticity can indicate muscle condition objectively (Yanagisawa et al. 2011) and it is determined from ultrasound shear imaging. Muscle elasticity is affected by muscle architecture, especially a degree of pennation angle. Also, in the case of active condition (exert torque by muscle contraction), muscle elasticity depends on the number of cross-bridge (the myosin heads attach to the actin filaments, Herzog 2007). In this way, there is a different causation which influences on muscle elasticity between passive and active condition. **PURPOSE** To compare the muscle elasticity of the plantar flexor muscle at an identical tendon force level of plantar flexion, between passive and active condition. **METHODS** The healthy men completed both passive and active condition tasks. In the passive condition, subject sat on the seat of dynamometer and seat their ankle joint was fixed to the foot-plate. Their ankle joint was rotated passively and passive torque was recorded at six different ankle joint angles (from 30° of plantar flexion to 20° of dorsiflexion, in each 10°). In the active condition task, subject exerted isometric plantar flexion torque under submaximal condition at 0° of ankle joint angle. Because ankle joint angle was different between passive and active condition to consistent tension of both conditions. We calculated tendon force using the value of moment arm (Maganaris et al. 2000). The target torque was adapted an identical of tendon force with maximal the passive torque in the passive condition task. Muscle fascicle length, pennation angle and elasticity of the medial gastrocnemius were measured by ultrasound shear imaging. **RESULTS** The values of tendon force and muscle elasticity were not significantly different on both conditions (tendon force:  $614 \pm 252$  N and  $638 \pm 270$  N, for passive and active condition, respectively,  $p=0.820$ , Muscle elasticity:  $158.4 \pm 33.8$  kPa and  $152.5 \pm 42.9$  kPa, for passive and active condition, respectively,  $p=0.739$ ). In addition, fascicle length in passive condition was longer than in active condition ( $63.0 \pm 6.4$  mm and  $49.4 \pm 7.1$  mm for passive and active condition, respectively,  $p<0.001$ ) and pennation angle was smaller ( $19.5 \pm 2.0^\circ$  and  $26.7 \pm 5.5^\circ$  for passive and active condition, respectively,  $p<0.01$ ). **CONCLUSION** Although there are different conditions in muscle architecture between passive and active condition, muscle elasticity did not different at an identical tendon force level. **References** Herzog W. (2007) *Biomechanics of the Musculo-skeletal System*, 169-225. Wiley, Chichester. Maganaris CN, Baltzopoulos V., Saegeant AJ. (2000) *Eur J Appl Physiol*, 83, 363-369 Yanagisawa O, Niitsu M, Kurihara T, Fukubayashi T. (2011) *Clin Radiol*, 66, 815-819 Email emika.kato@jpnssport.go.jp

## EVALUATION OF FORCE-VELOCITY AND POWER-VELOCITY RELATIONSHIP OF ARM MUSCLES

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**Introduction** A number of recent studies have revealed an approximately linear force-velocity (F-V) and, consequently, a parabolic power-velocity (P-V) relationship of multi-joint tasks (Yamauchi et al. 2009; Bobbert 2012; Samozino et al. 2012; Cuk et al. 2014). However, the measurement characteristics of their parameters have been neglected, particularly those regarding arm muscles, which could be a problem for using the linear F-V model in both research and routine testing. Therefore, the aims of the present study were to evaluate the strength, shape, reliability and concurrent validity of the F-V relationship of arm muscles. **Methods** Twelve healthy participants performed maximum bench press throws against the loads ranging from 20 to 70% of their maximum strength and linear regression model was applied on the obtained range of F and V data. The linear regressions directly revealed the maximum F (F-intercept;  $F_0$ ) and regressions slopes (a). They enabled the calculation of the maximum V (V-intercept;  $V_0=F_0/a$ ) and the maximum P outputs ( $P_0 = (F_0V_0)/4$ ). The P-V relationship was assessed by solely applying the parabolic model presuming that the F-V relationship is linear. One-repetition maximum bench press and medicine ball throw tests were also conducted. **Results** The observed individual F-V relationships were exceptionally strong ( $r = .96-.99$ ; all  $p<0.05$ ) and fairly linear, although it remains unresolved whether a polynomial fit could provide even stronger relationships. The reliability of parameters obtained from the linear F-V regressions proved to be mainly high ( $ICC>0.80$ ), while their concurrent validity regarding directly measured F, P, and V ranged from high (for maximum F) to medium-to-low (for maximum P and V). **Discussion** The findings add to the evidence that the linear F-V and, consequently, parabolic P-V models could be used to study the mechanical properties of muscular systems, as well as to design a relatively simple, reliable, and ecologically valid routine test of the muscle ability of force, power, and velocity production. Future studies could focus upon the shape of F-V relationship of other tasks and the measurement properties of the obtained parameters. Generalization of the observed findings to other multi-joint tasks is also needed. **References** Yamauchi J, Mishima C, Nakayama S, Ishii N (2009). *J Biomech* 42(13), 2151-2157. Bobbert MF (2012). *J Appl Physiol* 112(12), 1975-1983. Samozino P, Rejc E, Di Prampero PE, Belli A, Morin JB (2012). *Med Sci Sports Exerc*, 44(2), 313-322. Cuk I, Markovic S, Nedeljkovic A, Kukolj M, Ugarkovic D, Jaric S (2014). *Eur J Appl Physiol*, 114 (8), 1703-1714. Contact aleksandar.nedeljkovic@fsfv.bg.ac.rs

## MUSCULOTENDINOUS MECHANICAL PROPERTIES AND LOWER LIMB MORPHOLOGY IN TRACK AND FIELD ATHLETES

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**Introduction** Training methods and types of the movements of track and field athletes are different depending on athletic events. It is expected that mechanical properties of muscles and tendons would be affected by different track and field events. Therefore, the purpose of this study was to examine mechanical properties of both muscle and tendon tissues of triceps surae for different competitive track and field athletes. **Methods** Eleven sprinter (SP: 19 ± 1 years, 1.74 ± 0.05 m, 61.7 ± 5.6 kg), 12 long-distance runners (LD: 20 ± 1 years, 1.70 ± 0.07 m, 55.8 ± 6.6 kg), 12 jumper (JU: 20 ± 1 years, 1.75 ± 0.05 m, 64.7 ± 3.8 kg) and 8 thrower (TH: 20 ± 1 years, 1.73 ± 0.06 m, 84.6 ± 3.6 kg) participated in this study. Passive ankle joint torque were measured during passive dorsiflexion of each 10° from the 20° plantar-flexion position to 10° dorsiflexion position. During passive movements, the fascicle elongation of medial gastrocnemius (MG) was measured by B-mode ultrasonography and then passive muscle stiffness was calculated. By using the same method as Kubo et al. (2001), MG tendinous tissues stiffness was measured during the ramp maximal voluntary isometric planter flexion. The MG fascicle

length, pennation angle and cross-sectional area (CSAAT) of Achilles tendon and patella tendon length, CSAPT were evaluated by B-mode ultrasonography. Results During passive movements (20°→10°), passive stiffness of MG was significantly higher in TH than in all other groups. There were significant differences of the mechanical properties of MG fascicle and tendinous tissues between competitive track and field athletes. The CSAAT was smaller in LD than in all other groups. The CSAPT was significantly higher in SP than in all other groups. Discussion These differences between groups could be related to specific training program to lower legs for each group, such as high impact stress with the short contact time in SP and JU, and low impact stress but high volume in LD, and high impact stress with long contact in TH. References Keitaro,Kubo.,Hiroaki,Kanehisa.,Tesuo,Fukunaga.(2001) Eur J Appl Physiol 85:226-232 Contact Takayuki.1104@gmail.com

### THE EFFECT OF KINESIO TAPING ON QUADRICEPS PAIN PREVENTION

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The Effect of Kinesio Taping on Quadriceps Pain Prevention Yang, H.W. 1, Chou,P.H. 1,2 1 Department of Sports Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan 2 Division of Sports Medicine, Department of Orthopedic Surgery, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan Introduction: Kinesio taping is widely used by rehabilitation professionals in recent years. In the past literatures, the application of Kinesio taping had shown inconsistent results on enhancing functional performance. The purpose of this study is to investigate the effect of Kinesio taping on quadriceps pain prevention. Methods: Twelve subjects (mean age  $\pm$  20.33 ) were randomly divided into two groups: Kinesio taping group (KT), and control group (CT). Kinesio-Taping was applied on vastus medialis, rectus femoris and Vastus lateralis muscle. They were asked to perform concentric contraction to induce muscle fatigue. In both groups, the maximal muscle strength, the Visual Analogue Scale of Pain (VAS-P) were recorded before the concentric contraction, immediately after the concentric contraction and 24 hours after the concentric contraction. Results: The maximal muscle strength of the KT group showed fewer declines than the CT group after concentric contraction. The KT group declines  $3.45 \pm 1.06$  N-m and the CT group declines  $4.28 \pm 2.05$  N-m. The VAS-P showed no significant differences the between two groups. Discussion: The Kinesio taping provided significant proprioceptive enhancement at the knee joint after uphill walking with poor proprioceptive ability. This may support its use in sports medicine for preventing knee injuries. But Chang HY[1], et al indicated Kinesio taping did not change maximal grip strength in either group. The effects of Kinesio taping on muscle maybe consider soft tissue proportion. Conclusion: The Kinesio taping is good for muscle fatigue decline after oncentric contraction that few to decrease maximal muscle strength. But the pain feeling is no improve. References 1. Chang, H.Y., et al., The Effectiveness of Kinesio Taping for Athletes with Medial Elbow Epicondylar Tendinopathy. International Journal of Sports Medicine, 2013. 34(11): p. 1003-1006.

### LONG TERM EFFECTS OF LANDING SURFACE STABILITY ON JUMP PERFORMANCE

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Introduction Although the direct effect of unstable surfaces on explosive performance may be a reduction in power output due to impaired agonist functioning, the long term effects of unstable training (UST) on stable ground performance have not been investigated. With training, the sensorimotor system may modulate the detrimental compensatory responses on performance by reducing the sensitivity required on a stable surface, thereby allowing greater agonist force production due to reduced shear forces. This study examined the long-term effects of dynamic UST on subsequent stable ground drop jump (DJ) performance. Methods 44 males undertook a 6-week progressive DJ intervention training, randomly assigned to one of 5 groups based on landing surface stability: mini-trampoline (MT), BOSU, MIX (BOSU & stable), stable, or control. In total, participants completed 1080 DJs. Each session involved 4\*5 DJ from 3 drop heights which progressed from 0.2-0.4m (weeks 1&2) to 0.8-1m (weeks 5&6). Testing consisted of 3 maximal DJ at 0.2, 0.6 and 1m onto a Kistler force platform (1000Hz) before and after the training intervention. Instruction was to minimise ground contact time (GCT) while maximising subsequent jump height (JH). Results DJ1.0m: Statistical analysis showed that all groups improved their GCT ( $p < 0.01$ ). For RSI, all training groups significantly improved their performance (MT: 37%, BOSU: 28%, Stable: 25%, MIX: 18%,  $p < 0.01$ ) except for control (-7%). For JH, the performance for all training groups remained unaltered while the control experienced a significant drop in their pre-training values (-18%,  $p < 0.05$ ). DJ0.6m: Significant improvements over time ( $p < 0.01$ ) were found for all groups for GCT and RSI whereas for JH, the post-pre changes for stable (17%) and control (-9.4%) differed significantly ( $p < 0.01$ ) while the other groups remained unchanged. DJ0.2m: Significant improvements over time in GCT were recorded ( $p < 0.01 - 0.05$ ) with BOSU (-75ms) and controls (-80ms) exhibiting the greatest changes while the same trend was noted for RSI. In terms of JH, the post-pre changes for stable (+2.8cm) and control (-4.1cm) differed significantly ( $p < 0.01$ ) with the other groups unchanged. Discussion On the debate about UST, no significant differences in performance measures were observed between stable and unstable (BOSU, MT or MIX) groups. These findings of similar improvements suggest that exposure to UST may be as effective as stable training, which may be of particular interest to athletes in-season when reduced impact loads are necessary. Furthermore, although all groups recorded improvements in GCT across jump heights, JH was impaired in the controls at each height. Therefore, improvements in GCT alone may not represent the whole spectrum of performance adaptations when analysing DJ performance. Contact: l.pollitt@leedsbeckett.ac.uk

## Mini-Orals

### MO-SH14 Sports statistics & Analysis III

#### ACTIVITY PROFILE OF 'LA LIGA' SOCCER PLAYERS DURING A SEASON

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Introduction Distances covered and number of sprints is value information about the activity profile of professional soccer players during a match in a whole season (Di Salvo et al., 2009). The profile is clearly influenced by the playing position and the half period of matches

(Di Salvo, 2007). Fatigue seems to be a great influence on distances covered and number of sprints when comparing the first half and the second (Mohr et al. 2003). The aim of the study was to describe the distances covered and the number of sprints executed by the 'La Liga' players in a whole season. Methods A group of 197 male soccer players (age =  $28.2 \pm 1.8$ , height:  $177.3 \pm 4.8$  cm, weight:  $68.5 \pm 6.9$  kg), members of the different teams of the professional Spanish league, participated in this study. We analyzed the matches of the season 2011-2012. Kinematic parameters of activity were assessed using the Mediacoach System®, the official 3D tracking system of 'La Liga' based on time-motion analysis using 16 cameras that detects the position of players on the field. A descriptive analysis and a profile comparison by playing positions were performed. Results Central midfielders are the position that covers greater distances but not significantly greater than the other field players ( $p > .05$ ). Similar patterns were observed when comparing first half and second half. In respect the distance covered per minute, attackers covered  $10.54 \text{ m}\cdot\text{min}^{-1}$  more than central defenders and  $8.41 \text{ m}\cdot\text{min}^{-1}$  less than central midfielders ( $p < .01$ ). Moreover, lateral defenders covered  $9.92 \text{ m}\cdot\text{min}^{-1}$  more than central defenders and  $9.04 \text{ m}\cdot\text{min}^{-1}$  than central midfielders ( $p < .01$ ). We also found significant differences between positions in number of sprints. Significant differences in distance covered and number of sprints between first and second half were also found. Discussion The findings confirm the differences in distance covered and number of sprints in different playing positions in top-class soccer players (Mohr et al. 2003; Di Salvo et al., 2007). Differences between the profiles were also observed when comparing the first and the second half. In conclusion, different profiles could justify the use of different strategies for conditioning strategies in soccer. References Di Salvo V, Baron R, Tschan H, Calferon Montero FJ, Bachl N, Pigozzi F. Performance characteristics according to playing position in elite soccer. *Int J Sports Med* 2007; 28 : 222 – 227 Di Salvo V, Gregson W, Atkinson G, Tordoff P, Drust B. Analysis of high intensity activity in premier league soccer. *Int J Sports Med* 2009; 30 :205 – 212. Mohr M, Krstrup, P., Bangsbo, J. Match performance of high-standard soccer players with special reference to development of fatigue. *J Sports Sci*, 2003, 21.7: 519-528.528.

### RELATIONSHIPS BETWEEN EXPERIENCE OF PLAYING GAMES AND THE EXPERT KNOWLEDGE IN FEMALE BASKETBALL PLAYERS

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Introduction For proceeding advantageously with a basketball game, it is necessary to understand the tactics of one's own team and opponent team, personal data, and so on. Players need not only to acquire physical and fundamental skills, but also to understand the terminology of basketball and team tactics. Therefore the purpose of this study was to reveal relationships between experience of playing games and the expert knowledge in basketball. Methods 27 females who play basketball at Division I basketball team in Kyushu Collegiate Basketball Federation voluntarily participated in this study. They were divided into 3 groups; 1st group (players in the starting lineup and players with the average playing time for longer than 20 minutes per game:  $n = 10$ ), 2nd group (players with the average playing time for less than 20 minutes per game:  $n = 7$ ), 3rd group (players who had no chance to play during the season:  $n = 10$ ). The expert knowledge for basketball was measured by the test that was created based on the report of Sakaguchi et al.(2009) the test was composed of 39 questions asking the terminologies, rules, and set-play for team's tactics. The total score and the score of each category were calculated for analyzing 3 groups. The one-way analysis of variance was used to test differences in the average score for each question within 3 groups. The multiple comparisons of Bonferroni were used for post hoc test. The significance level was set at less than 5% ( $p < 0.05$ ). Results In the total score and score of the set-play, 1st group showed significantly higher values than 3rd group. ( $p < 0.05$ ). On the other hand, the total score and score of each category were not significantly different between 1st group and 2nd group, and between 2nd group and 3rd group. Discussion 1st group showed high score in all categories. However, there were no significant differences among 3 groups in the terminology and rule for basketball. This result may be due to that terminology and rule are basic knowledge for the basketball players. The reason why the significant difference was observed in the set-play was that 3rd group had less experience for playing the set-play than 1st group. It became clear that the experience of playing games is related to the expert knowledge for basketball. Contact sakuragikimiko@cis.fukuoka-u.ac.jp

### QUANTIFICATION OF NUMBER AND APPEARANCE RATIO OF A BALL CONTROL PLAY FACING OPPONENT'S GOAL IN SOCCER.

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Introduction In soccer, a play which a field player receives the ball facing the opponent's goal is important for getting a score. However, there was no earlier finding on quantifying the ball control play with relation to wins and losses of matches. The purpose of this study aimed to quantify the ball control play facing opponent's goal with relation to wins and losses of the matches. In this study, a play which a field player receives the ball facing the opponent's goal was defined as oriented control play. Methods Participants were collegiate soccer players. Their 19 official and practice matches were recorded with a video camera (win,  $n = 9$ ; draw,  $n = 5$ ; loss,  $n = 5$ ). From the obtained films, the number of oriented control plays, and shoots within the opponent's goal, which is an index of offensive effectiveness (Harris & Reilly, 1987), were counted for each player. The number of oriented control plays and shoots was divided into playing time of each player, and converted to total number in 90 minutes. Appearance ratio (%) of the oriented control play was expressed as percentage of the number of oriented control plays to total number of the ball receiving plays. Result The results revealed that the number of oriented control plays was higher in win matches ( $14 \pm 10$  times) than in draw ( $11 \pm 12$  times) or loss ( $9 \pm 6$  times) ones. The appearance ratio of the oriented control plays was also higher in win ( $80 \pm 20\%$ ) and draw ( $83 \pm 27\%$ ) matches than in loss ( $74 \pm 24\%$ ) ones. The number of the shoots within the opponent's goal in 90 minutes were 8 for win matches, 5 for draw matches, and 6 for loss matches without the significant differences. The number of shoots within the opponent's goal in win matches was related to the number ( $r = 0.94$ ) and appearance ratio ( $r = 0.58$ ) of oriented control plays with median effect size. Conclusion The number and appearance ratio of oriented control plays is higher in win matches compared to loss matches, and is associated with the number of shoot within the opponent's goal. These findings indicate that the oriented control play is important for getting a score. Reference Harris, S., & Reilly, T. (1987) Space, teamwork and attacking success in soccer, *Science and Football*. 322-328.

## EXPLORING GOAL SCORING CERTAINTY IN SOCCER: THE INFLUENCES OF PLAYING LEVEL, PASSING AND SHOOTING SKILLS, AND FATIGUE

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**Introduction** The notion of opposition interaction (Gréhaigne et al., 1997; O'Donoghue, 2009) states that the analysis of performance for invasion games must consider the interaction between the two opposing teams to be more valid. Therefore, goal scoring in soccer can be considered as a process of creating penetration against the opposition defence. In so doing, we managed to distinguish between goals scored under tight defensive pressure (lower scoring certainty) and a more favourable loose defensive pressure (higher scoring certainty) conditions created by the opposing team. Thus, the aim of this study was to investigate the influences of playing level, passing and shooting skills, and fatigue as determining factors of scoring certainty in soccer. **Methods** The sample included 2600 team possessions ended with a goal from seasons 2011, 2012 and 2013 of the Norwegian top professional league (1951 goals) as well as seasons 2011-12 and 2012-13 of the UEFA Champions league (649 goals), after excluding 192 (6.9%) goals from the penalty kicks. The sample was further distinguished into goals scored under tight (984 goals) and loose (1592 goals) defensive pressure conditions prior to goal scoring. Kappa correlation coefficient were used to test inter-observer reliability for all observational variables, while Chi-square analysis and multiple logistic regression were used to determine odds ratio in which the dependent variable was whether or not a goal was scored under loose defensive pressure condition. We used a significance level of  $P < 0.05$  in all tests. Results Kappa correlation values ranged from 0.43 to 0.95 showed acceptable levels of inter-observer reliability for all observational variables used (Altman, 1991). Multiple logistic regression analyses revealed that only passing and shooting skills had influence on whether a goal was scored under a more favourable condition (loose defensive pressure); with scoring from outside the 16 m area showing the greatest influence compared to scoring within the 5 m area (OR=4.91, 95% confidence interval: 3.48 to 6.93,  $P=0.001$ ). The factors of playing level and fatigue showed no significant effect. **Discussion** The results suggest that, regardless of the playing level, the chance to increase goal scoring certainty may increase from 56% to as far as five folds when employing a combination of passing and shooting skills including five or more passing sequences compared to four or less, four or more finishing touches compared to one touch, and making shooting attempt from 16 m compared to 5 m area of the pitch. **References** Altman DG. (1991). Practical statistics for medical research, 403-409. London: Chapman & Hall. Gréhaigne JF, Bouthier D, David B. (1997). *J Sports Sci*, 15, 137-149. O'Donoghue P. (2009). *IJPAS*, 9, 26-46. Contact albin.tenga@nih.no

## COMPARISON OF PHYSICAL PERFORMANCE AMONG BRAZILIAN YOUNG HANDBALL PLAYERS OF DIFFERENT AGE-CATEGORIES BEFORE AND AFTER CONTROLLING FOR MATURATION

Ramos, M., Souza, C., Luz, T., Medeiros, D., do Carmo, B., Cunha Júnior, A., Luz, L.

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**INTRODUCTION** The aim of this study was to examine the physical performance among brazilian young handball players of different age-categories before and after controlling for maturation. **METHODS** The sample consisted of 18 and 24 male players of two age-categories, that is, respectively, under 14 (U14) and under 16 (U16) years. Body mass (BM), stature (S), sitting height (SH) and skinfolds of triceps and subscapular were measured. The body mass index (BMI) and body fat percentage (BF%) were calculated. Biological maturation was evaluated by the somatic maturity offset method. The physical performance assessment was performed by six tests: 2-kg ball throw, vertical jump, 30-m dash, 40-s dash, 30-s sit-ups and 20-m shuttle run. Descriptive statistics and Kolmogorov-Smirnov normality test were performed. Student t test was used to compare age groups ( $p < 0.05$ ). Subsequently, analysis of covariance was used to examine groups' differences after controlling for somatic maturation given by maturity offset. **RESULTS** Comparison between age-categories were significant for age (U14: 13,6±0,1 years; U16: 15,7±0,1 years) and maturation (U14: -0,4±0,7 years; U16: 0,8±0,8 years). Among morphological variables, age-categories differences were noted for BM and BMI (U14

## RUGBY UNION MOVEMENT PATTERNS: THE IMPACT OF FATIGUE AND SUBSTITUTE PLAYERS

Tee, J., Lambert, M.I., Coopoo, Y.

*University of Johannesburg*

There is currently limited information on the effect of fatigue and the impact of substitutes on movement patterns in rugby union match play. This study investigated the effect of half on movement patterns of whole game players in different positions (backs and forwards), and how these contrast with substitute players. Global positioning system (GPS) data was collected from 105 professional match participations. Relative distance (m.min<sup>-1</sup>) increased in the second half for whole game players ( $7 \pm 9\%$ ), due to an increase in walking distance (1st  $29.1 \pm 3.9$  vs. 2nd  $34.2 \pm 3.7$  m.min<sup>-1</sup>). High-intensity running distance decreased in the second half for forwards (1st  $10.0 \pm 5.0$  vs. 2nd  $8.6 \pm 3.8$  m.min<sup>-1</sup>), but increased for backs (1st  $10.6 \pm 3.2$  vs. 2nd  $11.4 \pm 2.5$  m.min<sup>-1</sup>). Substitutes demonstrated increased relative jogging (Start  $19.5 \pm 5.0$  vs. Sub  $23.8 \pm 6.3$  m.min<sup>-1</sup>) and striding (Start  $7.9 \pm 2.4$  vs. Sub  $10.6 \pm 5.5$  m.min<sup>-1</sup>) distance versus whole game players. These findings indicate that fatigue may result in reduced high-intensity running distance and that this effect may be managed through the use of substitutes.

## VIDEO BASED NOTATIONAL ANALYSIS OF BALL POSSESSION IN US NATIONAL COLLEGIATE ATHLETIC ASSOCIATION DIVISION I MEN'S LACROSSE

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**Introduction:** Objective performance measures are important for success in sports. For the game of lacrosse most scientific papers focus on lacrosse specific injuries and its relevance (Carter et al., 2010; Lincoln et al., 2013), whereas in other areas there is a paucity of lacrosse specific research. Therefore, this study aims to describe and define the game structure and performance indicators of NCAA Division I Men's Lacrosse. **Methods:** With the help of a verified observation system (Hughes & Franks, 2008; Lames, 1994; O'Donoghue, 2010), seven playoff games of the 2013 NCAA Division I Men's Lacrosse Championship have been analyzed to assess duration, location and match activities of ball possession and its start and end events, respectively. Further differences between the winning- and losing team for relevant indicators have been collected to gain a better understanding of the game. **Results:** Results showed that there are an average of 107.3 ball possessions per game with a mean duration of 32.7 seconds. Of the 660.1 passes 70% were between 10 and 20 yards,

17% longer than 20 yards and 13% shorter than 10 yards. Most of the 530.3 runs per game were longer than 15 yards (61%), shorter runs (39%) occurred less often. The most frequent event that started a ball possession was a ground ball (39%) in contrast to a wide shot (21%) that ended a possession most of the time. Most ball possessions (n=14.0) was gained in the defending goal crease area, and lost in front of the opponent's goal (n=43.4), respectively. The match winner had a significantly higher overall ball possession time and more pass and run occurrences than the loser ( $p<0.05$ ). Discussion: In conclusion, college men's lacrosse is a game of possession with the total time of possession as a relevant indicator for success. Moreover, it can be concluded that longer single possession time and higher numbers of shots, passes and runs are closely related to success. Further, this study has shown that notational analysis seems to be a valuable source to get a better knowledge of lacrosse. References: Carter, E. A. et al., (2010). Int. J of Injury Control and Safety Promotion, 17(2), 111–118. Hughes, M., & Franks, I. M. (Eds.). (2008). The essentials of performance analysis: an introduction. Routledge. Lames, M. (1994). Systematische Spielbeobachtung. Philippka. Lincoln, A. E., et al., (2013). Video Incident Analysis of Concussions in Boys' High School Lacrosse. Am J of Sports Medicine, 41(4), 756–761. O'Donoghue, P. (2010). Research methods for sports performance analysis. Routledge. Contact: richard.hauer@univie.ac.at

## EFFECTS OF AUGMENTED QUANTITATIVE FEEDBACK ON HIGH SCHOOL BASKETBALL PLAYERS' PERFORMANCE

Tay, C.

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High school sports coaches tend to offer qualitative feedback of players' performance after a game because of limitations. As touchpads become more ubiquitous, it is easier to record and track quantitative aspects of players' performance. Several researchers have indicated that quantitative feedback is more useful to athletes than qualitative feedback (e.g., Magill and Wood, 1986; Reeve and Magill, 1981; Smoll, 1972.). Thus, this study was carried out to investigate the effects of receiving augmented quantitative feedback on high school basketball players' fitness levels and game performance statistics (GPS) in Singapore. Tests were carried out to assess the physical attributes of the players – speed, agility, lower and upper body strength and power, and aerobic endurance. This battery of tests was compiled after a review on sports fitness testing (e.g., Gore, 2000). GPS was captured during the competition season using an iPad application (iScore; Faster Than Monkeys, Inc, iScore Sports, USA). Using iScore, players' GPS were tracked for each game. Data was captured over a period of 2 years. Quantitative feedback offered the players a first time in-depth analysis of their game performance and fitness levels. The female team improved their jump heights by 8.9%, agility and speed scores by about 14%. The male players improved their agility and speed scores by 13.5% and their V02 max scores from 48.4 to 57.2. The female 2-points and 3-points field goal percentages improved by 4.2% and 2.1% whilst the male team had 2.5 more rebounds per game and increased their free throw percentage by 8%. Receiving quantitative as well as qualitative feedback appears to have raised both fitness levels and game performance in the basketball teams that were studied. A limitation of the study is the lack of control groups or historical data to show that improvements were not due to practice or game experience. However, the athletes have found the additional quantitative feedback beneficial, for instance, areas of weaknesses could be identified and improved upon. References: Ian M. Franks (1997). Use of Feedback by Coaches and Players. Science and Football III. New York, USA: Taylor & Francis Smoll, F.L. (1972) Effects of precision of information feedback upon the acquisition of a motor skill. Research Quarterly, 43, 489-493. Reeve, T.G. and Magill, R.A. (1981) Role of components of knowledge of results information in error correction. Research Quarterly for Exercise and Sport, 52, 80-85. Magill, R.A. and Wood, C.A. (1986) Knowledge of results precision as a learning variable in motor skill acquisition. Research Quarterly for Exercise and Sport, 57, 170-173. Christopher John Gore, PhD, Australian Institute of Sport (2000). Physiological Tests for Elite Athletes, Pp225-232

## BIASED PENALTY CALLS IN THE NATIONAL HOCKEY LEAGUE

Swartz, T.

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This talk investigates penalty calls in the National Hockey League (NHL). Our study shows that teams that are leading in a match are more likely to have the next penalty called against them. Also, we observe that teams that have taken more penalties in a match are less likely to have the next penalty called against them. The biases that we have identified are not uniform amongst referees. We investigate specific referee effects across the NHL.

## TACTICAL ANALYSES OF BRAZILIAN FEMALE NATIONAL HANDBALL TEAM IN 2012 LONDON OLYMPICS

Vallner, T.T.1, Mercadante, L.A.1, Monezi, L.A.1, Almeida, A.G.2

*1: School of Applied Science, University of Campinas (Brazil), 2: Pontifícia Universidade Católica de Campinas (Brazil)*

Introduction Technical-tactical analyses in sports are an important tool to understand the game. Technical information is widely used by teams and is documented by the organizers of international championships. However, tactical information are less present in literature and further absent in female literature. From this point of view, this study aims to describe the tactical elements to analyze the offensive behavior of Handball Team. Methods Data was obtained by six videos of the Brazilian Female National Handball Team in 2012 London Olympics. The data from the videos considered: number of occurrences of each attack system: positioned (P) and fast-break (FB); offensive tactical elements: piston movement and sidestepping (PS), feint (F), crossing (CR), pass and go (PG), curtain (C) e block (B), as well as the number of shots, goals and efficiency of each one. To quantify these variables, the videos were played in Windows Media Player software 2014. Descriptive statistics were performed using mean and standard deviation of the data to verify the offensive tactical elements invested and the most efficient by the Brazilian Team in this competition. Results For the attack systems, P composed 91% of attacks, with an average ( $\bar{x}$ ) of  $58 \pm 6$  attacks and turnovers (to) per match and efficiency ( $\bar{y}$ ) of 50%. FB composed 9% with  $\bar{x} = 6 \pm 3$ ,  $\text{to} = 2 \pm 1$  and  $\bar{y} = 66\%$ . The most used tactical element (u) was the PS, with 63% of all attacks, with  $\bar{x} = 32 \pm 7$ ,  $\text{to} = 8 \pm 3$ , and  $\bar{y} = 50\%$ , followed by F ( $\bar{u} = 17\%$ ,  $\bar{x} = 9 \pm 2$ ,  $\text{to} = 3 \pm 1$  and  $\bar{y} = 93\%$ ), B ( $\bar{u} = 9\%$ ,  $\bar{x} = 8 \pm 2$ ,  $\text{to} = 0,6 \pm 0,8$  and  $\bar{y} = 58\%$ ), CR ( $\bar{u} = 8\%$ ,  $\bar{x} = 4 \pm 1$ ,  $\text{to} = 1 \pm 1$  and  $\bar{y} = 68\%$ ), PG ( $\bar{u} = 3\%$ ,  $\bar{x} = 1 \pm 0,5$ ,  $\text{to} = 0,5 \pm 1$  and  $\bar{y} = 66\%$ ). Curtain hadn't significant values. Discussion In comparison with this study, Ramari (2008) also used the tactical element quantity in male and female team. This author described the tactical element fixation as the most used. However this tactical element was not efficient expected. For the type of attack, Ferrari (2008) emphasizes the importance of FB in winning teams. Our aim was to implement a tactical analysis model which would allow quantification of the most used and efficient tactical elements to improve the training and understand the game using the example of the Brazilian Team in this competition. This type of analysis could determine the individual performances as well as group and team, assessing the interaction within team and the team with opponent. References FERRARI, W., SANTOS J., Simões V. Offensive Process Analysis in Handball: Identification of Game Actions that Differentiate Winning from



Losing Teams. American Journal of Sports Science. Vol. 2, No. 4, 2014, pp. 92-96. doi:10.11648/j.ajss.20140204.14 RAMARI, C. F. Análise técnico-tático de handebol de equipes da categoria cadete. 2008. 85f. Trabalho de Conclusão de Curso-Physical Education-University of Campinas, 2008.

**16:20 - 17:50**

## Invited symposia

### IS-PM08 TEAM SPORT & HEALTH \*

#### PLAYING FOOTBALL TO PREVENT CHRONIC DISEASES

Krustrup, P.

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It is now well-known that physical training is a cornerstone in the prevention and treatment of lifestyle diseases and it has recently been concluded that sport participation reduces all-cause mortality by 20-40% (Khan et al. 2012). Over the last 6 years, we have published 70 scientific articles describing the activity profile, physiological demands, fitness effects and health benefits of recreational football for untrained individuals across the life span, documenting that small-sided football (3v3 to 7v7) has broad spectrum fitness and health effects for 6-80-year-old participants, as it combines elements of high-intensity interval training (HIIT), endurance training and strength training (Krustrup et al. 2010, 2013). Small-sided football played 3v3, 5v5 or 7v7 elicits high heart rates and involves multiple intense actions such as sprints, turns, jumps, tackles, dribbles and shots, independently of age, gender, fitness status, socio-economic status and prior experience (Randers et al. 2010), providing effective cardiovascular training with multiple effects on VO<sub>2</sub>max, heart structure and function, endothelial function, capillarisation, lipid profile and oxidative enzyme activity, as well as multiple favorable effects on muscle mass, muscle function, postural balance and bone mineralisation (Krustrup et al. 2010). Recently, we investigated the health effects of football for patient groups with hypertension, type 2 diabetes and prostate cancer. Just 3 months of football training, 2x1 hour/week, lowered systolic and diastolic blood pressure by 12/8, 8/8 and 11/9 mmHg, respectively, in three RCT's, which is a more pronounced effect than usually seen after 3-6 months training interventions (Krustrup et al. 2013). Twice-weekly 45-60-min football sessions over 3 months was also shown to increase lean body mass, muscle strength and bone mass for elderly men with prostate cancer undergoing androgen deprivation therapy (Uth et al. 2014). These results and other recent results will be presented at ECSS in Malmø, altogether providing evidence that recreational football is an effective type of HIIT training that can improve fitness and serve as effective prevention, treatment and rehabilitation of noncommunicable diseases for individuals across the life span. Khan KM, Thompson AM, Blair SN et al. Lancet 2012; 380(9836):59-64. Krustrup P, Aagaard P, Nybo L et al. Scand J Med Sci Sports 2010; 20(S1):1-13. Krustrup P, Randers MB, Andersen LJ et al. Med. Sci Sports Exerc 2013; 45(3):553-560. Randers MB, Nybo L, Petersen J et al. Scand J Med Sci Sports 2010; 20(S1):14-23. Uth J, Hornstrup T, Schmidt JF et al. Scand J Med Sci Sports 2014; 24(S1):105-112.

#### FOOTBALL FANS IN TRAINING : A WEIGHT LOSS AND HEALTHY LIVING PROGRAMME DELIVERED TO MEN AGED 35-65 BY SCOTTISH PREMIER LEAGUE FOOTBALL CLUBS

Hunt, K.

*University of Glasgow*

Research on gender and health has recognized how constructions of masculinities may inhibit men's interest and participation in healthier lifestyles and health promoting interventions. Recently there has been increasing interest in how sports-based organizations may be utilized to engage otherwise 'hard-to-reach' men. The challenge now is to translate theoretical understandings of gender into effective interventions to improve health, and address public health priorities. One public health problem is the rapidly increasing levels of obesity in many parts of the world. In Scotland, around 4 in 5 men are 'overweight' or 'obese', and on current trends nearly 50% of UK men will be obese by 2030. A 5-10% weight loss can produce significant health benefits. However, attempts and motivations to manage weight are gendered in many ways. Existing weight management programmes are failing to attract men; they are often viewed as being geared towards women and fail to take account of how cultural constructions of masculinity influence men's feelings about their bodies and their attitudes towards health promoting activities. We report the development and evaluation of Football Fans in Training (FFIT), an innovative evidence-based, gender-sensitised weight management and healthy living intervention which is delivered to overweight/obese men in professional football clubs by club community coaches. We evaluated the effectiveness of Football Fans in Training (FFIT) in a two-arm, pragmatic RCT in 13 SPL football clubs. Men (n=747), aged 35-65, with BMI $\geq$ 28kg/m<sup>2</sup>, were randomly assigned to either the intervention (undertook FFIT within 3 weeks of measurement) or comparison (undertook FFIT 12 months later) group, and followed to 12 months. The results of the trial demonstrate the effectiveness and cost-effectiveness of FFIT. Men in the intervention group lost a significantly higher percentage of their weight at 12 weeks and 12 months (primary outcome) than those in the comparison group, and more achieved a clinically-significant ( $\geq$ 5%) weight loss at both time points. Improvements in other directly-measured and self-reported secondary outcomes were also significantly greater in the intervention group. Drawing on qualitative data, we will also present findings on men's experiences of taking part in FFIT, demonstrating: the power of the football club as a 'draw' for these men; and their positive experiences of making lifestyle changes in this context. The study demonstrates the importance of working with rather than against prevailing cultures of masculinity, and challenges views that men are uninterested or unwilling to make positive lifestyle changes. It demonstrates the great potential of sport settings for health improvement.

## PROSTATE CANCER PATIENTS' EXPERIENCES WITH PARTICIPATION IN FOOTBALL – A QUALITATIVE INVESTIGATION OF THE 'FC PROSTATE' RANDOMIZED CONTROLLED TRIAL

Midtgaard, J., Krusturup, P., Uth, J., Brasso, K., Hornstrup, T., Bruun, D.M.

*Rigshospitalet (Copenhagen University Hospital)*

**INTRODUCTION** Evidence is accumulating that exercise-based rehabilitation improves physical capacity and quality of life in cancer survivors. However, recruitment and persistence of male cancer patients in rehabilitation and physical activity are low and novel health promotion strategies are warranted. Therefore, the aim of this investigation was to gain an understanding of the meaning of recreational football as a team and interaction oriented health promoting activity in men with prostate cancer (n=26) including perceived acceptability of severe injuries. **METHODS** A qualitative sub-study of the 'FC Prostate' randomized controlled trial was conducted based on 6 focus group interviews (n=6x4-6) and 20 hours of participant observations. Moreover, in-depth individual interviews were performed with four men who had been injured during football training. Data were analysed using framework analysis and descriptive phenomenology, respectively. **RESULTS** The framework analysis produced 11 sub-themes that were structured into three overarching themes: 1) motivational drivers; 2) united in sport and 3) confirmation of own capacity. The findings indicated that participants regarded football as a welcome opportunity to regain control and acquire a sense of responsibility for own health without assuming the patient role, and football training legitimized and promoted mutual caring behaviour in a male-oriented context. In addition, the phenomenological analysis indicated that injuries acquired through football training, was experienced as 'perfectly normal', i.e. a psychologically harmless and meaningful consequence of participating in sport supporting the participants' feeling of masculinity. **DISCUSSION** The study suggests that football due to its cultural representation of masculine ideals may be a potent and unique strategy for increasing recruitment and adherence to physical activity in prostate cancer patients. Moreover, the risk of severe injuries related to football training may be outweighed not only by already documented positive physiological effects but equally by the men's acceptability and perceived psychological benefit of participation in high-risk sporting activities.

## Oral presentations

### OP-PM17 Physiology: Cardiovascular II

#### THE EFFECT OF RAST ANAEROBIC TEST ON CIRCULATING HEMATOPOIETIC AND ENDOTHELIAL PROGENITOR CELLS IN ATHLETES

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**Abstract Introduction** Some studies documented the changes of hematopoietic stem cells and endothelial progenitor cells following aerobic exercise for example, (Mobius-Winkler et al., 2009; Thijssen et al., 2006). However, far less information is available on hematopoietic stem cells and endothelial progenitor cells in response to anaerobic exercise. Thus, the aim of this study was to know the responses of hematopoietic stem cells and endothelial progenitor cells in the 24 hours after RAST anaerobic test. **Methods** Ten healthy male's athlete's age (20.90± 0.27 y) performed running - based anaerobic sprint test (RAST). RAST consisted of six 35m sprint runs at maximum speed with 10 sec rest between them. Blood samples taken pre, and immediately, 30 min, 2h, 6h and 24h post exercise were analyzed for hematopoietic stem cells (HSCs), endothelial progenitor cells (EPCs), Vascular Endothelial Growth Factor Types – A (VEGF-A), Nitric Oxide (NO), Lactic Acid (LA) and White Blood Cells (WBCs) . **Results** After RAST anaerobic test, there was significant increase in HSCs, EPCs, VEGF-A, NO, LA and WBCs (p < 0.05). This increase will be at different rates according to the timing of taking blood sample. HSCs and EPCs were in the maximum rate of increase 6h after RAST anaerobic test. In addition to VEGF-A was in the maximum rate of increase 30min after RAST anaerobic test and NO 24h after RAST anaerobic test. While LA and WBC were in the maximum rate of increase immediately after RAST anaerobic test. The researcher noted that there was a significant decrease in HSCs immediately after the RAST anaerobic test (p<0.05). **Discussion** Increase in HSCs and EPCs was a result of many mechanisms represented by an increase in NO and VEGF-A after RAST anaerobic test. While the researcher sees that the increase in WBCs and LA after RAST anaerobic test immediately, led to muscle fatigue and inflammation in tissues which result in rapid migration of HSCs to the tissues that need it. And this explains the immediate decrease of HSCs in peripheral blood after RAST anaerobic test. **References** Mobius-Winkler S, Hilberg T, Menzel K, Golla E, Burman A, Schuler G, Adams V. (2009 ). J Appl Physiol, 107:1943–1950. Thijssen DH, Vos JB, Verseyden C, van Zonneveld AJ, Smits P, Sweep FC, Hopman MTE, de Boer HC. (2006). Aging Cell, 5:495–503. Email: aboshady1989@yahoo.com

#### ISCHEMIC PRECONDITIONING REDUCES THE CARDIOVASCULAR RESPONSE DURING THE MUSCLE METABOREFLEX ACTIVATION

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**Introduction** The typical hemodynamic response to the activation of the muscle metaboreflex (MR) is an increase in mean blood pressure (MBP). This response is the consequence of the activity of type III and IV free nerve endings in the muscle which respond to metabolite accumulation. In normal subjects, the activity of these nerve endings leads to increase in sympathetic tone, thereby causing systemic vascular resistance (SVR) and cardiac output (CO) elevation (Crisafulli et al. 2003). It has been recently demonstrated that ischemic preconditioning (IP) can reduce the discharge of these nerve endings (Amann et al. 2013). The aim of the present study was to test the hypothesis that IP was able to reduce the hemodynamic response during the MR. **Methods** Ten healthy male subjects (32.5±3.5 yrs) were enrolled and randomly assigned to the following study protocol: 1) control tests (CT) to assess the cardiovascular response to MR, which consisted in a post-exercise (dynamic handgrip, DH) muscle ischemia (PEMI) to study the MR and a control DH-recovery (CER) session. 2) the PEMI test was after IP, obtained with 3 cycles of 5 minutes ischemia-reperfusion in the forearm. Central hemodynamics were evaluated by means of impedance cardiography and echocardiography. The hemodynamic response due to MR activation was assessed by calculating the PEMI – CER test difference in each cardiovascular variable. **Results** The main findings were that, after IP the MBP response to PEMI was blunted as compared to the standard MR activation test (7.2 ± 6.5 vs. 3.6 ± 7.5 mmHg). Moreover, after IP SVR response to MR was reduced, whereas CO was unchanged. **Conclusion** Our results indicate that IP can effectively reduce the cardiovascular activation

during the MR recruitment. Probably this was the consequence of a reduction in type III and IV nerve ending sensibility to metabolites accumulation. This fact could have practical implications in sensation of fatigue-related and in the IP-mediated increase in physical performance (Crisafulli et al. 2011). Crisafulli A et al. Muscle metaboreflex-induced increases in stroke volume. *Med Sci Sports Exerc* 2003; 35: 221-228. Crisafulli A et al. Ischemic preconditioning of the muscle improves maximal exercise performance but not maximal oxygen uptake in humans. *J Appl Physiol* 2011; 111: 530-536. Amann M et al. Peripheral fatigue limits endurance exercise via a sensory feedback-mediated reduction in spinal motoneural output. *J Appl Physiol* 2013; 115: 355-364.

### THE RELATIONSHIP BETWEEN BLOOD FLOW AND POST-EXERCISE RECOVERY: A RANDOMIZED SINGLE-BLIND PLACEBO-CONTROLLED STUDY.

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*INSEP*

**Introduction** Competitive sport requires athletes to complete multiple bouts of high-intensity exercise with limited rest periods, which are not sufficient for full recovery. It appears therefore necessary to assist, with adequate recovery strategy, in restoration of physiological systems to a preexercise state in preparation for subsequent exercise. This study investigated how different leg blood flow levels undertaken for the duration of a short-term ( $\leq 30$ -min) recovery period after high-intensity sprint cycling affected subsequent exercise performance, blood lactate clearance and heart rate recovery. **Methods** 33 trained athletes completed 2 multiple 30-s Wingate test (WAnT) sessions, 3 x 30-s WAnT (WAnT 1-3) and 1 x 30-s WAnT (WAnT 4), on a cycling ergometer. Tests were separated by a randomly assigned 24-min recovery intervention consisting in either: neuromuscular electrical stimulation-induced blood flow (NMESBF+; Veinoplus Sport, Paris, France), placebo stimulation (NMESPlacebo), passive rest (PAS) or blood flow restriction (BFR). Measures of blood flow by strain gauge plethysmography, blood lactate and heart rate were regularly recorded throughout the recovery period. Performance values were obtained from peak power and mean power during WAnT 1 and WAnT 4. The effects of the different recovery setups were examined using traditional probability statistics and magnitude of correlation. **Results** A large ( $r = 0.68$  (90% CL 0.42; 0.83)), and a very large ( $r = 0.72$  (90% CL 0.49; 0.86)) positive correlation was observed between the change in blood flow and the change in mean power and peak power, respectively, following the recovery interventions. Examination of blood lactate and heart rate revealed no recovery effect. **Discussion** These data support the assumption of an effective, positive correlation between the blood flow increase and the performance recovery from high-intensity exercise. An increase of the oxygen supply to the exercised muscles (Zarrouk et al. 2011) and glucose uptake by the muscle cells (Heyman et al. 2009) as well as an acceleration of muscle metabolic by-products removal (Malone et al. 2012) could potentially explain the performance recovery improvement observed with the blood flow stimulation protocol used here (i.e. NMESBF+). Furthermore, these findings highlight a potentially greater physiological role of neuromuscular electrical stimulation in recovery than the hypothesized psychological role. **References** Heyman E, DE Geus B, Mertens I, Meeusen R. (2009) *Med Sci Sports Exerc*, 41, 1303-1310. Malone JK, Coughlan GF, Crowe L, Gissane GC, Caulfield B. (2012) *Eur J Appl Physiol* 112, 2421-2432. Zarrouk N, Rebai H, Yahia A, Souissi N, Hug F, Dogui M. (2011) *J Athl Train* 46, 386-394. Contact rachel.borne@insep.fr

### EXERCISE TRAINING INCREASES THE INHIBITORY EFFECTS OF PROSTACYCLIN ON PLATELETS IN POST-MENOPAUSAL WOMEN

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**Background** Following blood vessel injury and exposure of sub-endothelial collagen, circulating platelets aggregate to form a thrombus plug that prevents blood loss. In a healthy cardiovascular system, the endothelium continuously produces prostacyclin to inhibit unwarranted platelet aggregation. However, cardiovascular disease can reduce the platelet sensitivity to the inhibitory effects of prostacyclin [1] and rupture of an atherosclerotic plaque can lead to uncontrolled platelet aggregation and life-threatening thrombosis. Menopause is associated with endothelial dysfunction and an increased cardiovascular risk profile [2]. It is not yet known how exercise influences platelet function in post-menopausal women. **Aim** To investigate if a period of exercise training in sedentary post-menopausal women affects their platelet responsiveness to the inhibitory effect of prostacyclin. **Method** These are preliminary results from the ongoing Copenhagen Women Study (approved by the Copenhagen Ethics Committee). Four sedentary healthy post-menopausal women (aged 50-55 years) were tested at baseline and after 12 weeks of supervised spinning training (1h interval training above 80% of maximal heart rate, 3 times/week). Catheters were inserted into their femoral artery and vein and prostacyclin (epoprostenol sodium) was infused through the femoral artery at three different doses (2.5ng, 5ng and 10ng/dl leg volume/min). Blood was collected from the femoral vein into 3.2% citrate vacutainers and centrifuged (10 min, 180g) to obtain platelet rich plasma. A 96-well plate assay [3] was used to measure 1µg/ml collagen-stimulated platelet aggregation. Data are presented as mean  $\pm$  SEM % platelet aggregation from n=4 post-menopausal women, analysed using one-way ANOVA with Bonferroni post-hoc test. **Results** Before the training intervention, the arterial prostacyclin infusion resulted in a dose-dependent inhibition of the collagen-induced platelet aggregation (baseline: 85 $\pm$ 4 %, 2.5ng: 55 $\pm$ 11 %, 5ng: 24 $\pm$ 5 %, 10ng: 0 $\pm$ 0 %,  $p < 0.05$ ). After the 12-week training intervention, the % platelet aggregation at baseline remained the same but the inhibitory effect of the prostacyclin was significantly enhanced (baseline: 90 $\pm$ 3 %, 2.5ng: 24 $\pm$ 8 %, 5ng: 8 $\pm$ 4%, 10ng: 2 $\pm$ 2 %,  $p < 0.05$ ). **Discussion** Introducing post-menopausal women to regular exercise makes their platelets more than twice as sensitive to the inhibitory effects of prostacyclin. Since effective prostacyclin inhibition of platelet aggregation is essential for preventing thrombosis, these preliminary results indicate that regular physical activity have protective anti-thrombotic effects on platelet function in post-menopausal women. **References** [1] Kahn, N et al. *Circ Res*. 1990. 66:932-940. [2] Taddei S et al. *Hypertension* 1996. 28(4):576-82. [3] Lordkipanidzé M et al. *Blood*. 2014. 20;123(8):e11-22. Contact mhs@nexs.ku.dk

### PHYSIOLOGICAL RESPONSES OF FIREFIGHTERS TO A FLASHOVER TRAINING

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**Physiological responses of firefighters to a flashover training** **Introduction** Firefighting imposes high physiological and psychological strains. This is due to the variety of physically demanding tasks firefighters perform at an emergency scene as well as high ambient temperatures and wearing protection gears. However, most studies investigated simulated task-testing in absence of environmental stressors such as high ambient temperatures in order to determine the physical loads of firefighting. Moreover, firefighter's responses to suddenly occurring dangerous situations such as a flashover have not been established yet. A flashover describes the phenomenon

where a fire reaches its ignition temperature and spreads quickly due to inflammable gases emitting from materials and exposed surfaces in an enclosed area. This dangerous situation is explicitly trained by firefighters in a burning container that simulates flashovers. The aim of this research was to examine the contribution of aerobic and anaerobic energy systems to the physical performance of German firefighters in a flashover training. Methods Sixteen professional firefighters (age  $38.9 \pm 8.9$  yr, height  $177.3 \pm 6.9$  cm, weight  $81.5 \pm 9.3$  kg) performed firefighting tasks with a simulation of the flashover phenomenon in a container. In advance, a treadmill test in order to establish peak oxygen uptake ( $VO_{2peak}$ ), ventilatory threshold (VT1) and respiratory compensation point (RCP) was done under laboratory conditions. Three intensity zones were identified according to the HR values corresponding to VT1 and RCP. Simulated task-testing included ladder climb, hose advance and extinguishing different kinds of fires across the enclosed area of the training container. Subjects wore full protective clothing (24.5kg) and a self-contained breathing apparatus for air supply. Heart rate (HR) and depletion of air supply were measured during the drill. Results Mean time to complete the training was  $16.1 \pm 1.7$  min with a mean heart rate of  $147.8 \pm 12.4$  bpm across 16 subjects. The depletion of air supply averaged  $140.7 \pm 20.3$  bar. According to preliminary data of 6 firefighters, subjects spent  $18.9 \pm 11.0$  % of training-time below VT1,  $66.6 \pm 8.0$  % of time between VT1 and RCP and  $13.9 \pm 12.6$  % of time above RCP. These subjects performed the training with a mean percentage of 81.7% of maximal HR. Discussion According to our results, the highest energy contribution during a flashover training comes from the aerobic-anaerobic system (time spent between VT1 and RCP). Moreover, we found evidence for a high contribution of the anaerobic system in the second half of the flashover drill. Subjects with a higher  $VO_{2peak}$  in relation to age were able to supply a greater percentage of the total energy demand aerobically resulting in less physiological strain. Our results demonstrate the importance of an appropriate training level for professional firefighters.

### **A POWER-LAW MODEL REDUCES VARIABILITY IN TIME-TO-EXHAUSTION**

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**INTRODUCTION** A large inter-individual variability in time-to-exhaustion (TTE) occurs when working at the same relative intensity. This may be because exercise intensity prescribed as a percentage of  $VO_{2max}$  ignores differences in metabolic and neuromuscular stress. This study compared the inter-individual variability in cycling TTE when exercise intensity was prescribed using two different methods; as %  $VO_{2max}$ , or a power-law model. We also examined if TTE was related to muscle oxygen saturation, or one leg  $VO_{2max}$  expressed as a ratio of two leg  $VO_{2max}$ . **METHODS** Seventeen trained male cyclists (mean  $\pm$  SD;  $34 \pm 11$ y;  $178 \pm 6$ cm;  $75 \pm 10$ kg;  $VO_{2max}$   $4.39 \pm 0.51$ L.min<sup>-1</sup>) completed two incremental exercise tests to exhaustion (one leg and two leg) on a cycle ergometer to determine  $VO_{2max}$ . The exercise intensity for TTE at %  $VO_{2max}$  trials was set at 88% and 109%  $VO_{2max}$ . A power-law was derived from 3 TTE trials at 85%, 95% and 105% maximum minute power. This was then used to predict the intensity for TTE lasting exactly 20 min and 3 min. Participants then returned to the lab on two separate occasions, completing 2 x TTE trials on each occasion, with 30 min rest between trials. The tests of TTE for %  $VO_{2max}$  and power-law were administered in a randomised order. Thigh maximal leg oxygenation ( $sO_{2leg}$ ) was measured throughout the incremental tests and lower intensity TTE trials using near infrared spectroscopy (NIRS).  $VO_2$ , breathing frequency and heart rate were recorded throughout and blood lactate post-exhaustion. Participants self-rated their RPE throughout the TTE trials, by indicating when they felt it increased. Between participant coefficients of variation was calculated for each TTE trial. Comparisons between %  $VO_{2max}$  and power-law were made using an F-distribution. Pearson's correlation was used to investigate any relationships between variables. Data are presented as the means  $\pm$  SD. The level of significance was set at  $P < 0.05$ . **RESULTS** The coefficients of variation for the TTE trials were 58% and 29% for %  $VO_{2max}$  and power-law trials respectively ( $P < 0.05$ ). The ratio between one leg and two leg  $VO_{2max}$  did not relate to TTE performances for the %  $VO_{2max}$  ( $r^2 = -0.01$ ) and the power-law ( $r^2 = 0.46$ ) trials. Deoxygenated hemoglobin and TTE were negatively correlated ( $r^2 = -0.67$ ) for the %  $VO_{2max}$  trial; however, a positive correlation ( $r^2 = 0.60$ ) was found for the power-law trial. **CONCLUSION** Deriving a power-law model reduces variability in TTE and suggests that it may be a better method for standardising exercise intensity as it reduces inter-individual variability by 50%. The reason for the inter-individual variability in TTE warrants further investigation, but appears to be partly related to the methods used to standardise exercise intensity.

### **Invited symposia**

#### **IS-PM16 JSPFSM-RISK FACTORS AND BIOMARKERS OF REDUCED SKELETAL MUSCLE FUNCTION IN OLDER AGE –JAPANESE & EUROPEAN EXPERIENCE**

##### **ASSOCIATION OF HIGHER SERUM ADIPONECTIN LEVEL AND TRADITIONAL JAPANESE DIETARY PATTERN WITH REDUCED SKELETAL MUSCLE STRENGTH AND QUALITY OF LIFE OF OLDER JAPANESE**

Nagatomi, R.

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Reduced skeletal muscle mass accompanied by reduced force production in older age, namely sarcopenia, leads not only to increased risk of fall-associated fractures but also to loss of ability to live independently. Consequently, reduced muscle strength practically determines the quality of life of older people. In Japan, like in many other countries, older persons who demonstrate reduced ability to live independently are supported by long-term nursing care at home or at specialized institutions. In a prospective population study of Japanese people of 70 years and older, we investigated factors influencing two major outcomes, fall associated fracture and disability free living without official accreditation of long term care. Interestingly traditional Japanese diet characterized by low animal products and higher amounts of vegetables and whole grains, having similarities with Cretan or Mediterranean diet considered as healthy diet, was associated with higher incidence of fall associated fracture as compared to dietary pattern rich in poultry and meat (1). In a separate middle-aged population study in the same city in Japan, we focused on grip strength and leg extension power as outcome measures, and found that serum adiponectin level was inversely associated with grip strength and lower leg extension power (2). Back to the older population study, we found higher serum adiponectin level was inversely associated with disability-free survival requiring no long-term care requirement (3). Further analysis of the older population revealed that higher serum adiponectin is a risk factor for decreased muscle function (4). Serum adiponectin, otherwise considered as one of the potent protective adipokines for cardiovascular diseases, appears to have negative impact on skeletal muscle function. In the same middle-aged cohort study we identified traditional Japanese dietary pattern was associated with higher serum adiponectin (5) and was associated with reduction in systolic or diastolic blood pressure (6).

Higher serum adiponectin level was also associated with decreased incidence of acquiring cardiovascular risk factors in the same population (7). Taken together, a balanced life style is required for active health in the older age, Biomarkers such as adiponectin may be useful to identify an balanced life style for independent living. 1. Monma Y et al. BMC Geriatr 10: 31, 2010. 2. Huang C et al. Nutr Metab Cardiovasc Dis 2013. 3. Hozawa A, et al. J Gerontol A Biol Sci Med Sci 67: 530-536, 2012. 4. Huang C et al, Nutr Metab Cardiovasc Dis 2015 (E-pub) 5. Guo H et al. Nutr Metab Cardiovasc Dis 22: 277-284, 2012. 6. Niu et al. Eur J Nutr 2015 (E-pub) 7. Niu K et al. Int J Cardiol 167: 2318-2320, 2013.

### COUNTERMEASURE AGAINST BLUNTED SKELETAL MUSCLE STEROIDOGENESIS

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Sarcopenia is the age-associated loss of skeletal muscle mass and strength that develops slowly over decades and becomes a significant factor to disability among the elderly population. Progressive resistance training (RT) has been shown to be an effective countermeasure for sarcopenia. Previous studies have demonstrated that RT can increase skeletal muscle mass significantly in both young and older individuals, although anabolic response to a bout of resistance exercise may be blunted with aging. Sex steroid hormones regulate various physiological processes in target tissues. Dehydroepiandrosterone (DHEA) and its sulphate derivate (DHEA-S) both play critical roles in maintaining steroidogenesis in peripheral tissues. However, aging is also associated with decreased serum levels of DHEA, which has been linked to accelerated progression of sarcopenia. We have recently investigated the plasma and intramuscular levels of steroid hormones and steroidogenic enzyme expressions in healthy young and older men. Although intramuscular hormone levels and steroidogenesis-related enzyme expressions declined significantly with ageing, a 12-wk resistance training program restored both plasma and intramuscular sex steroid hormone levels in older men. Furthermore, improvements in intramuscular sex steroid hormone levels correlated with the training-induced changes in muscle size and strength. The presentation will include recent findings on possible biomarkers that may relate to the outcome of RT-induced muscle hypertrophy. Reference: Sato et al. FASEB J. 28(4):1891-7, 2014

### COUNTERACTING SKELETAL MUSCLE LOSS WITH AGEING: INFLUENCE OF NUTRITION AND EXERCISE

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The demographic prognosis in all European countries reveals a marked increase in the number of citizens above the age of 65 years in the coming decades. Along with improved treatments of various diseases also recommendations on actions and strategies appealing to self-responsibility among the elderly and pre-elderly citizens as to maintain muscle mass and physical independency must be made visible through public campaigns to limit the societal expenses on elderly care. Despite the endemic nature of loss of muscle mass and function with increasing age, sarcopenia is a treatable process. Although, multiple causes are responsible for the sarcopenic process, two factors however, are crucial for any actions in its prevention or delay, namely muscular exercise training and sufficient nutritional intake, with emphasis on adequate amounts of protein. Scientific evidence suggests that the need for daily protein intake for the elderly population is higher than the current recommendations from the World Health Organisation. Therefore, it could be claimed that in the future modern society, healthy elderly people should not suffer from functional disability. This presentation will present some scientific evidence for the beneficial effect on maintenance of muscle mass through enhancing protein intake for the elderly and elucidate the gaps of evidence on longitudinal investigations. Further, the potential of muscular training on muscle mass and strength will be faced with the paradoxical sedentary tendency and the incomppliance with heavy loading exercises among elderly people. The question being, what impact more tolerable exercise training with lower contraction intensity has on the development of muscle mass in elderly people. A strategy to study the impact different types of exercise training and protein intake in the elderly population will be presented with the off-set in the inter-disciplinary CALM-project, conducted at University of Copenhagen, Denmark.

## Oral presentations

### OP-PM43 Training & Testing: Teamsport I

#### QUANTIFICATION OF SESSION RATINGS OF PERCEIVED EXERTION IN ELITE SOCCER REFEREES

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Quantification of session ratings of perceived exertion in elite soccer referees Weston, M Teesside University (Middlesbrough, UK). Background Session ratings of perceived exertion (sRPE) are commonly used to measure training session intensity. Despite this, comparisons of sRPE from different training activities with match sRPE and analyses of repeated-activity sRPE elude the literature. Presented here, therefore, is an in-depth quantification of elite soccer referees' training and match sRPE. Methods Eight professional soccer referees were monitored over four consecutive soccer seasons. Data were collected as part of the sport science support provided to the referees and during each season detailed training diaries were compiled for each referee, including training activity, duration and intensity. The training activities included in this study were high-intensity aerobic intervals (sports scientist prescribed sRPE range 6-9; work:rest ratio ~1:1), repeated-sprints (5-7; ~1:3), medium-intensity aerobic (3-5; continuous), speed (including agility exercises, 2-5; ~1:10) and strength (including functional/injury prevention exercises, 2-4; ~1:10). Referees recorded their sRPE (CR10 scale) 30-min after each session to obtain a global session intensity rating (Foster et al., 2001). Only data from the competitive season were included in the analysis. Data were analysed via linear mixed modelling, with magnitude-based inferences subsequently applied. Results A total of 4659 sessions were included in the present study (high-intensity 688, repeated-sprints 387, medium-intensity 509, speed 963, strength 809 and match 1303). Mean  $\pm$  standard deviation sRPE was 6.6  $\pm$  1.7 AU (high-intensity), 5.8  $\pm$  1.6 AU (repeated-sprints), 4.6  $\pm$  1.6 (medium-intensity), 3.6  $\pm$  1.3 (speed), 3.1  $\pm$  1.1 (strength) and 6.4  $\pm$  1.6 (match). Contrasts of training sRPE with match sRPE were trivial for high-intensity (1.9%;  $\pm$ 90% confidence limits 8.6%), possibly small for repeated-sprints (-11.1%;  $\pm$ 7.6), likely moderate for medium-intensity (-28.7%;  $\pm$ 6.1%), likely large for speed (-43.7%;  $\pm$ 4.7%) and most likely large for strength (-51.7;  $\pm$ 4.1%). Within- and between-referee variability in training and match sRPE ranged from 0.9  $\pm$  0.1 to 1.1  $\pm$  0.1 AU and 0.7  $\pm$  0.3 to 1.4  $\pm$  0.7 AU, respectively. Conclusions The magnitude of the difference between training and

match sRPE is smallest when the intensity of the prescribed training is highest and the work:rest ratio lowest, providing further support for the relevance of high-intensity intervals and repeated-sprints as match-specific training for elite soccer referees. Despite large differences between match sRPE with speed and strength sRPE, speed and strength sessions should remain integral to the training process as they help to prepare referees for the entire spectrum of match-related physical demands. Finally, for all activities sRPE were relatively consistent within and between referees. References Foster et al. (2001). *J Strength Cond Res* 15(1), 109-115 Contact m.weston@tees.ac.uk

### ARE PHYSIOLOGICAL ABILITIES OF PROFESSIONAL SOCCER PLAYERS POSITION SPECIFIC?

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*University of Hamburg*

**Introduction** Soccer position-specific indices of physiological abilities of professional soccer players are seldom reported in the literature. These are especially evident when identifying new soccer player talent, training regimen, and player tactics (1,2,3). **Methods** We developed a standardized test protocol as results of observations of professional soccer team of the second German soccer division over 5 consecutive soccer seasons [Goalie G (n=9), Defense D (n=26), Mid-field MF (n=29) and Forward F (n=13)]. We measured sprint times (5m and 30m), counter movement jump (CMJ), the endurance (individual anaerobic threshold, IAT) in the field as well as strength and power measurements relative to their body weight in selected tests. The tests were administered before the start of the soccer season in July. **Results** The results indicated condition-specific indices of the second German soccer division players (mean±SD) and identified differences in position-specific indices [CMJ (cm): G 39.1±3.6Δ; D 42.3±3.8; MF 42.0±5.0; F 43.3±3.1Δ / Sprint (s): G 4.3±0.1#Δ; D 4.1±0.2#; MF 4.0±0.2; F 4.0±0.1Δ / Squat (kg/kgKG): G 1.3±0.1#Δ; D 1.6±0.2\*#; MF 1.4±0.2\*; F 1.5±0.3Δ / Body fat: G 13.3±2.1#X; D 10.1±1.6\*#+; MF 11.6±2.7\*X; F 12.5±2.6+]. \*significant between D & MF; +significant between D & FP; #significant between D & G; #significant between MF & FP, X significant between MF & G; Δ significant between FP & G. **Discussion** The results of our study revealed significant differences in physiological abilities depending on assigned soccer game position. The designed test protocol suggests that position-specific and physiological tests may serve in identifying indices that could be useful in constructed soccer specific training, game specific positions, and competition. **References** 1. Bloomfield J, Polman R, O'Donoghue P (2007). *J Sports Sci Med* 6, 63-70. 2. Di Salvo V, Baron R, Tschan H, Calderon Montero FJ, Bachl N, Pigozzi F (2007). *Int J Sports Med* 28, 222-27. 3. Lago-Penas C, Casais L, Dellal A, Rey E, Dominguez E (2011). *J Strength Cond Res* 25, 3358-67. Contact ruediger.reer@uni-hamburg.de

### CHANGES IN MUSCULAR AND NEUROMUSCULAR FUNCTIONS FOLLOWING SOCCER-SPECIFIC FATIGUE IN YOUTH MALE FOOTBALLERS

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**Introduction** In soccer, ACL injury is frequent injury predominantly non-contact in nature (Walden et al., 2011). It was suggested that fatigue increases the risk of ACL injury and that the risk is higher in youth compared to adults. Limited epidemiological studies indicate that this relative risk of ACL injury may peak in pubertal and post pubertal years. It was also suggested that the functioning of the muscular and neuromuscular mechanisms that contribute to knee stability in a fatigued state was influenced by growth and maturation (Lloyd et al., 2011). The aim of the study is to assess the impact of soccer-specific fatigue on leg stiffness and reactive strength in young soccer players. **Methods** A group of young soccer players (n=19; age 15.1±0.6 years; body height 170.5±10.9 cm; body weight 60.4±9.9 kg) participated in this study. The reactive strength index (RSI), and lower limb stiffness were assessed before and after soccer-specific fatigue protocol SAFT90. The RSI was determined by means of a drop jump test. Absolute leg stiffness was determined based on the data of a two-legged sub-maximal hopping test. Absolute leg stiffness was normalized to relative leg stiffness (relative to leg length and body mass). **Results** A statistically significant decrease (t=2.41, p=0.027, d=0.55) in the RSI and absolute leg stiffness (t=3.96, p=0.001, d=0.91) and relative leg stiffness (t=3.94, p=0.001, d=0.90) after soccer-specific fatigue protocol was observed. **Discussion** The findings of our study of young soccer players indicate that soccer-specific fatigue induces a significant decrease in the functioning of the muscular and neuromuscular mechanisms that contribute to knee stability in a fatigued state. The results of the study support the opinion that boys have a lower ability to resist to neuromuscular fatigue than adult men and consequently are subject to an increased risk of ACL injury in a fatigued state (Oliver and Smith, 2010). The results point to the importance of prevention strategies included into training programs and the importance of the dosage of training load and game load in youth athletes. **References** Lloyd RS, Oliver JL, Hughes MG, Williams CA (2011). *J Electromyogr Kinesiol*, 22(1), 37-43. Oliver J, Smith P (2010). *J Electromyogr Kinesiol*, 20, 973-979. Walden M, Hagglund M, Werner J, Ekstrand J (2011). *Knee Surg Sports Traumatol Arthrosc*, 13, 3-10.

### CHANGE-OF-DIRECTION SPEED TRAINING IN MINIMALIST FOOTWEAR MAY PROVIDE ADDITIONAL PERFORMANCE GAINS IN JUNIOR AUSTRALIAN RULES FOOTBALLERS

Graham, S.1, Taylor, S.1, McLaughlin, P.2, Zois, J.1

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**Introduction** Training in minimalist shoes can increase straight-line running speed and jumping performance. This study assessed the performance adaptations following a five-week change-of-direction speed training program using a minimalist shoe intervention. **Methods** Junior Australian Rules Footballers were recruited (n=20) and stratified into a minimalist shoe (n=9) and shod group (n=11). The training program consisted of five-weeks of change-of-direction speed cutting exercises and plyometric activities. Pre and post change-of-direction speed measures (AFL agility test, Agility T-test and Pro agility shuttle) and foot muscle strength (plantar flexion, greater toe flexion and lesser toe flexion) were recorded pre and post the training program. Data was analysed using effect size statistics with 90% confidence intervals and percentage change to determine magnitude of effects. **Results** Minimalist shoes provided moderate gains compared to shod in two of the change-of-direction speed tests (AFL agility test -2.3 ± 2.3% ES:0.38, Agility T-test -2.0 ± 2.9% ES:0.41) and trivial in the other (Pro agility shuttle -0.1 ± 2.5% ES:0.01). Intrinsic foot strength measures showed moderate improvement in the minimalist shoe condition (greater toe flexion 8 ± 24% ES:0.2 right and 19 ± 32% ES:0.4 left) (lesser toe flexion 11 ± 30% ES:0.2 right and 11 ± 36% ES:0.2 left) compared to shod. Minimalist shoes moderately decreased extrinsic foot strength compared to shod (plantar flexion -10 ± 19% ES:0.4 right and -9 ± 13% ES:0.3 left). **Discussion** Junior Australian Rules Footballers experience some additional improvements compared to shod following five-weeks of change-of-direction speed training in minimalist shoes. A training program closer to eight weeks may be more beneficial. Additional gains may be attributed to the improved intrinsic foot strength capacity. These findings would be of particular interest to practitioners aiming to optimise agility training programs for young athletes.

## ANGIOTENSIN-CONVERTING ENZYME GENE EXPRESSION ASSOCIATED WITH SOCCER PLAYERS' PHYSICAL CAPACITIES

Coelho, D., Pimenta, E., Rosse, I., Carvalho, M., Silami-Garcia, E.

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**INTRODUCTION** Among the many genes that have an effect on sports performance, one of the most studied is the insertion/deletion polymorphism of the gene encoding the angiotensin-converting enzyme (ACE-I/D), as it affects the performance of both aerobic and anaerobic activities. **METHODS** Were evaluated 138 male athletes (categories Under-17, Under-20 and adults) of a Brazilian first division Soccer team. Genotyping of DNA from leucocytes was performed using polymerase chain reaction and restriction fragment length polymorphism methods. The athletes were genotyped in DD, ID or II. The following three parameters were investigated: first, speed, using a 30-m sprint test with speed measured at 10 m (V10), 20 m (V20), and 30 m (V30); second, muscular strength, using counter-movement-jump and squat jump tests; and third, aerobic endurance using the Yo-Yo endurance test. The athletes were ranked in ascending order according to their performance in each test. After which they were divided into quartiles, first quartile (0–25%, Weak), second quartile (25–50%, Normal), third quartile (50–75%, Good), and fourth quartile (75–100%, Excellent), and clustered according to genotype frequency. The X<sup>2</sup> was used to compare the genotype frequencies (DD, ID and II) within and between the different quartiles of performance rating. **RESULTS** We identified significant difference in test values V20 and aerobic capacity. In the case of the V20 observed higher frequencies of the ACE-DD genotype in Excellent performance group compared to the others. In the aerobic capacity test, there was greater higher frequency of ACE-II individuals in performance groups Excellent and Good compared to the others. **DISCUSSION** As in the present study, we have observed an increased frequency of the ACE-DD polymorphism in higher levels of competitive sports with anaerobic predominance (Costa et al., 2009) and when these modalities are compared to athletes modalities of aerobic predominance (Scanavini et al., 2002). The reverse also observed by these authors. It is concluded the players that have higher performance in aerobic and anaerobic tests are ACE-II and DD genotypes respectively. **REFERENCES** Costa A, Silva A, Oliveira A, Oliveira R, Granadeiro L. (2009). Efeitos do sistema reninaangiotensina- aldosterona e do polimorfismo I/D do gene da eca no desempenho esportivo. *Rev Bras Cienc Esporte*, 31, 9-24 Scanavini D, Bernardi F, Castoldi E, Conconi F, Mazzoni G. (2002). Increased frequency of the homozygous II ACE genotype in Italian olympic endurance athletes. *Eur J Human Genetics*, 10, 576-577. CONTACT danielcoelhoc@gmail.com

## Oral presentations

### OP-PM59 Health & Fitness: Age I

#### ASSOCIATION BETWEEN CARDIOVASCULAR FITNESS AND QUALITY OF SLEEP IN YOUNG ADULTS

Keng, C.F., Lin, C.Y., Chen, J.J., Lin, I.C., Ye, Y.J.

*National Yang Ming University*

**Background and purpose:** Young adults with sleeping disorders are increasing due to the changing of life style and stress, especially in college students. Poor quality of sleep are highly related to cardiovascular diseases and sudden death from overwork. However, the study of quality of sleep and cardiovascular fitness are lack of cardiac output data during exercise tests. Thus, we used a non-invasive monitor of cardiac output during exercise to investigate the association between cardiovascular fitness and quality of sleep in college students. **Methods:** A total of 42 college students (male: 21, female: 21, mean age: 20.57±0.737years; mean height:166.056±8.423 cm; mean weight:59.20±11.836) was recruited in this study. For sleep quality evaluation, a valid Chinese version of the Pittsburgh Sleep Quality Index (PSQI) was used. The definition of poor sleep was PSQI score >5. We used 6-minutes walking test as cardiovascular fitness tests. Cardiac output during exercise was measured by a non-invasive monitor (PhysioFlow®, Manatec type PF05L1, Paris, France ) with modified Bruce Protocol for 12 minutes treadmill walking. Independent t-tests were used in data analysis. **Results:** The basic data of body weight, body height, BMI, gender and age of poor sleep and control group were all non-significant. Subjects with poor sleep quality (PSQI score >5) were more likely to have lower levels of cardiovascular fitness. The fatigue and dyspnea level before exercise and fatigue level after exercise were significantly higher in the poor sleeping group (p<0.001, p=0.001, p=0.042). The diastolic blood pressure (DBP) was also higher in poor sleeping group before exercise (p=0.038). **Conclusion:** Poor sleeping quality would increase the fatigue and dyspnea level before and after exercise, and the DBP would also been interfered by the quality of sleep. People with higher level of fatigue and dyspnea might have higher risk of sudden death from overwork. Higher DBP in resting also imply the deficiency of cardiac muscle contractility. Further studies of cardiovascular disease should take the quality of sleep into consideration.

#### DEVELOPING OF MODEL HEALTH HOLISTIC CARE OF THE ELDERLY BY THE COMMUNITY PARTICIPATION IN TAM-BONBUGRASUNG AMPHOE NONGKEE BURIRAM PROVINCE IN THAILAND

Chuntiima, W.

*suranree university of technology*

**Introduction** This research has 3 objective to evaluate the quality of life and quantitative and focus group discussion of 11 stakeholders in the community. of the elderly , to analyze the relations between independent factors and dependent (the quality of life of the elderly ) and to find out viable strategies to improve the health holistic care for the elderly through individual, family care and community support. **Methods** The study comprises two steps of research design. The first step adopted a qualitative approach based on the interview of 243 elderly along multi – stage method. The quantitative result were used in the final step , and quantitative based on focus group discussion at the individual and family levels, and in-depth interviews at the community level of total 25 samples were studied. **Results** The Result showed that elderly average age of 70.6 years. The factor analysis for quality of life evaluation in elderly of the quality of life . A multiple regression analysis showed that the total of 13 independent variables could explain adjusted R square of 99.4 percent . Ten independent variables significantly relate to the quality of life **Discussion** To improve the quality of life for elderly , the strategies for each individual empowerment is to be well prepared for the following : knowledge and self- practice for a healthy life elderly . , on money – savings, self-reliant elderly and active elderly involving in family and community activities. At the community level , a proactive approach of strengthened community is need for community members supporters , and participation in community activities based on wisdom, culture and

available there. References Oakley, P. (1984) Geneva: International Office. Cohen J.M., UpHoff. N.T. (1981) Cornell University. Fornaroff, A. (1980) Geneva: World Health Organization. Contact weepo@sut.ac.th

### THE EFFECT OF HEALTH PROMOTION INTERVENTION ON CARDIOVASCULAR RISK FACTORS IN ACTIVE COMMUNITY DWELLING ELDERLY

Wang, Y.P., Tseng K.W., Chen, T.C., Tsai, M.W.

*National Yang Ming University*

**Introduction** People volunteered to participate the health promotion programs may have better healthy awareness and/or more active lifestyle (From et al.,2013; Haskell et al.,2007).However, it is uncertain the intervention remains effectively to modify cardiovascular (CV) risk factors even in active community dwelling elderly. The aim of this study was to compare the effect of 12-week health promotion programs involving different mode on CV risk factors in active community-dwelling elderly. **Methods** This was a retrospective cohort study. 66 participants (69.0±5.4 years) were included for study analysis. Based on usual physical activity (PA) and program attended, we categorized participants into 3 groups: moderate PA with exercise (Gr1, n=23), high PA with exercise (Gr2, n=20), and high PA with intensive stair climbing exercise (Gr3, n=23). Outcome variables including resting heart rate (RHR), systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol (TC) and fasting blood glucose (FBG) were extracted at baseline and program completion. Within group difference was assessed by paired t-test. One-way ANOVA was used to compare baseline data among groups, and one-way ANCOVA was used to compare the change of RHR and risk factors among groups. The significant level was set at  $p < 0.05$ . **Results** The baseline values were significantly different among groups except FPG. All subjects showed significantly change in SBP (-8.9±26.2 mmHg,  $p=0.029$ ), FBG (-7.1±27.6 mg/dL,  $p=0.005$ ) and TC (-22.6±41.2mg/dL,  $p<0.001$ ). Gr 1 got decrease in SBP(-8.7±17.8 mmHg,  $p=0.029$ ), FBG(-11.9±21.8 mg/dL,  $p=0.016$ ),and TC(-20.6±35.6 mg/dL,  $p=0.011$ ), Gr2 got decrease in TC(-50.3±50.8 mg/dL,  $p<0.001$ ), and Gr3 got decrease in RHR (-14.7±27.3 bpm,  $p=0.002$ ).By adjusting the baseline value, Gr 2 showed greater improvement in TC than the others( $p=0.010$ ) and more reduction in RHR in Gr3 than Gr1 and Gr2 ( $p=0.030$ ). **Discussion** A 12-week community-based health promotion program could modify and modestly improve some cardiovascular risk factors in active older adults. The effect showed more obvious in elderly with regular high PA behavior than moderate PA. Our results also highlighted the intervention mode and PA level dependent effect on CV risk factor modification in active community dwelling elderly. **References** From, S., Liira, H., Leppavuori, J., Remes-Lyly, T., Tikkanen, H., & Pitkälä, K. (2013). BMC Public Health, 13, 125. Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., Bauman, A. (2007). Med Sci Sports Exerc, 39(8), 1423-1434.

### THE EFFECT OF HIGH INTENSITY INTERVAL TRAINING ON THE BODY COMPOSITION AND FUNCTIONAL CAPACITY OF OLDER OBESE ADULTS

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*Stellenbosch University*

**Introduction** The implementation of High Intensity Interval training (HIIT) in older adults for health and fitness is relatively uncommon. However, the literature indicates that HIIT is well tolerated by older adults and clinical populations, while significant improvements in health and fitness are reported (Tjønnå et al.,(2008). Minimal studies have been done on older, obese adults. The aims of this study were to determine if HIIT was safe and more effective than a Moderate Continuous Aerobic Training protocol (MCAT) in changing the body composition and functional capacity (FC) of older obese adults. **Methods** 24 sedentary older adults (age 63±6 years; 37±8 % body fat) volunteered for this 16 week intervention study. They were randomly allocated into 2 groups that performed HIIT or MCAT. HIIT consisted of 4 x 4 minutes on a treadmill at 90-95% of age predicted maximum heart rate (APMHR) with 3 minutes of active recovery. MCAT consisted of treadmill walking for 47 minutes at 70-75% of APMHR. The two interventions were isocaloric (Tjønnå, et al., 2008). Body mass (BM), waist (WC) and hip circumference (HC) were measured according to the International Standards for Anthropometric Assessment and measured with a spring loaded, non-extensible anthropometric tape measure. Abdominal diameter (AD) was measured supine using a Holtain-Kahn abdominal calliper. FC was measured using the Timed up and Go test (TUG). The magnitude of the differences between the two programmes was calculated using Cohen's effect sizes. Ethics approval was obtained from Stellenbosch University. **Results** There was a large practically significant reduction in BM in the MCAT group (2.26 ± 1.2kg), with no significant change in the HIIT group (0.96 ± 1.69kg). Both exercise interventions resulted in statistically significant reductions in AD, WC and HC ( $p<0.0001$ ), but only small practically significant differences were observed between the groups (ES=0.07, 0.09 and 0.01 respectively).The change in FC was practically significant in both groups with a greater magnitude of difference in the HIIT group (HIIT 0.3 ± 0.39s; MCAT 0.2 ± 0.27s; ES=0.3). **Discussion** When work volumes are the same, a 16 week HIIT protocol results in positive changes in body composition and functional capacity similar to an MCAT protocol in older, obese adults. No adverse effects were reported. The findings suggest that HIIT can be a safe and effective method of training for older, obese adults, adding variety and possibly better compliance to regular exercise. **References** Tjønnå, A.E., Lee, S.J., Rognmo, Ø. et al. (2008). Aerobic Interval Training Versus Continuous Moderate Exercise as a Treatment for the Metabolic Syndrome A Pilot Study. American Heart Association, 118:346-354. Contact 15617572@sun.ac.za

### PREVALENCE OF PHYSICALLY DEPENDENT ELDERLY IS INFLUENCED BY OBESITY STATUS: THE EXERNET MULTICENTER STUDY

Alcazar, J., Mata, E., Gomez-Cabello, A., Pedrero-Chamizo, R., Gusi, N., Villa, J.G., Espino, L., Casajus, J.A., Gonzalez-Gross, M., Ara, I.

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**Introduction** Promoting older people to remain healthy and independent seems critical to reduce the negative consequences of aging. Therefore, it has been recommended that elderly should manage their body weight (1) and should be screened for disability in functional activities on an annual basis (2). To our knowledge, no studies reporting the prevalence of older people with problems of functional limitations using objective functional fitness (FF) tests and obesity assessment can be found. **Methods** A cross-sectional study was conducted on a representative sample of non-institutionalized Spanish older adults (n=3,136) aged from 65 to 92 years. Lower- and upper-body strength, agility and endurance were assessed using the Senior Fitness Test (3). Criterion-referenced standards for FF scores (3) were used as cut-off points to classify older people in 3 groups: physically dependent, pre-dependent and physically independent. Body composition was analysed using bioelectrical impedance, waist circumference and body mass index (BMI). Chi square and Cochran-Mantel-Haenszel tests were applied. **Results** The prevalence of low functioning-physically dependent elderly in Spain was 6.9%. No



difference between genders was found. Those subjects with problems of physical dependence showed higher levels of obesity both assessed by BMI (OR, 2.29) or body fat percentage (OR, 2.41), and also with central obesity (OR, 2.87) compared to the non-physically dependent group (all  $P < 0.01$ ). These associations remained significant when gender and age were considered (all  $P < 0.01$ ). Discussion Almost 7% of the non-institutionalized elderly population in Spain is physically dependent. Additionally, in physical dependent subjects the odds of being obese or having central obesity were more than two-fold higher compared to non-physically dependent subjects. These results are in agreement with data reported by Koster et al. (4). Interventions to prevent and treat the FF decline including obesity assessment should be a public health priority. References 1. Gomez-Cabello A, et al. *Obes Rev.* 2011;12(8):583-92. 2. Fried LP, et al. *J Gerontol A Biol Sci Med Sci.* 2004;59(3):255-63. 3. Rikli RE, Jones CJ. *Gerontologist.* 2013;53(2):255-67. 4. Koster A, et al. *J Am Geriatr Soc.* 2008;56(4):636-43. Contact julian.alcazar@alu.uclm.es

### **GENDER DIFFERENCES IN SELF REPORTED WALKING AND SITTING TIME IN PRE-DIABETIC PARTICIPANTS ENROLLED INTO A LIFESTYLE INTERVENTION: PRELIMINARY BASELINE RESULTS FROM THE PREVIEW PROJECT.**

Swindell, N.1, Drummen, M.2, Fogelholm, M.3, Handjieva-Darlenska, T.4, Lam, T.5, Larsen, T.6, Macdonald, I.7, Mackintosh, K.1, Martinez, A.8, McNarry, M.1, Pipard, L.5, Poppitt, S.9

*Raben A.6, Schlicht W.10, Simpson K.11, Stratton, G.1*

1: SU (UK) 2: UM (Netherlands) 3: HEL (Finland) 4: MU (Bulgaria) 5: NetUnion 6: UCPH (Denmark) 7: UNOTT (UK) 8: UNAV (Spain) 9: UOA (NZ) 10: USTUTT (Germany) 11: UNSYD (Australia) Low physical activity, high sedentary behaviour and insulin resistance are precursors of type-2 diabetes (Wilmot et al. 2012). The current study quantified walking and leisure time sitting (LTS) in a sub-study of pre-diabetic participants recruited into an on-going lifestyle intervention study (PREVIEW - PREvention of diabetes through lifestyle Intervention and population studies in Europe and around the World). Methods Pre-diabetic (WHO/IDF 2006), overweight BMI  $\geq 25.0$  kg/m<sup>2</sup> participants aged 25-70 years were recruited from 6 EU countries, Australia and New Zealand into a 3year diet and exercise program. At baseline prior to the start of the intervention, 652 participants (462 female) self-reported 7 consecutive days of walking time (all intensity) and LTS. Results There was no gender difference in mean ( $\pm$ SD) walking time 279 $\pm$ 204 min/wk (male) 295 $\pm$ 209 min/wk (female)  $p = 0.44$ ; 72% of men and 70% of women were sufficiently active according to international guidelines (WHO, 2010). Mean ( $\pm$ SD) sitting time did not differ by gender 1827 $\pm$ 988 (male) 1680 $\pm$ 926 min/wk (female);  $p = .09$ ; 50% of men and 40% of women exceeded 4h/d of LTS. There was a significant inverse relationship between walking and LTS in women ( $r = -.108$ ;  $p = .03$ ), but not men ( $r = -.039$ ;  $p = .63$ ). Conclusion After being screened for diabetes risk the majority of pre-diabetic participants self reported that they were sufficiently active (WHO 2010). In contrast LTS exceeded previously reported thresholds for increased risk (Sisson et al. 2009). These findings provide data on self-report activity of adults choosing to enter an intervention to help them reduce their risk of diabetes. These findings are based on subjective methods; future research will include objective measures. Funding FP7/2007-2013 Grant agreement no. 312057. NHMRC - EU Collaborative Grant, AUS. HRC (14/191) and UoA Faculty Research Development Fund, NZ The Cambridge Weight Plan References Sisson, S. et al., 2009. Metabolic Syndrome Related Disorders, 7(6), pp.529-36. WHO/IDF, 2006. Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia : report of a WHO/IDF consultation WHO, 2010. Global recommendations on physical activity for health Wilmot, E. et al., 2012. *Diabetologia*, 55(11), pp.2895-905. Email: 835228@swansea.ac.uk

## **Invited symposia**

### **IS-PM17 CSSS-ECSS exchange symposium: PHYSICAL ACTIVITY AND HEALTH PROMOTION**

#### **POLYMORPHISMS IN RAS CODING GENES ARE ASSOCIATED WITH EXERCISE TRAINING-INDUCED CHANGES IN CARDIORESPIRATORY FITNESS**

He, Z., Tian, T., Hong, P., Huang, C., Zhao, J., Wang, M., Li, R.

*China Institute of Sport Science*

Purpose: Individuals differ in the response to regular exercise. Our objective was to examine the hypothesis that tag SNPs polymorphism in the coding genes of the rennin-angiotensin system influences aerobic exercise training-induced changes in cardiorespiratory fitness through genotype-specific increases in Maximal oxygen uptake (VO<sub>2</sub>max). Methods: 596 normal body mass index (BMI), no regularly exercising subjects completed 16 week aerobic training. Ages are 20-59 year old. Among them, 344 are women. The exercise training load is 20-30min under 75%-85% AT in the first week, 85%AT and 30min from second to fourth week, 85%AT and 40min from fifth to eighth week, 95%AT and 40min from ninth to twelve, 100%AT and 40min from thirteen to sixth week. 89 tag SNPs were selected by haplotype and genotyped by a matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) platform. VO<sub>2</sub>max was measured breath-by-breath by a continuous incremental intensity protocol. Results: After 16 week aerobic training, VO<sub>2</sub>max (ml/min/kg) increased significantly. For male, it improved from 32.96 $\pm$ 7.88 to 34.21 $\pm$ 7.48ml/min/kg ( $P < 0.001$ ). For female, VO<sub>2</sub>max enhanced from 26.23 $\pm$ 5.14 to 27.70 $\pm$ 5.32ml/min/kg ( $P < 0.001$ ). For individual response, 44 males (17%) and 54 females (16%) decreased more than 10%, 82 males (33%) and 132 (38%) females increased more than 10%. For males, AGTR1 rs2675511 and REN rs4951313 were associated with VO<sub>2</sub>max training response, which can explain 3.5% individual difference. For females, FNDC5 rs3480, AGTR1 rs2675511, and AGTR1 rs385338 might explain 5% individual training response difference. Conclusion: Those results suggest that polymorphism significantly affect training-induced cardiorespiratory fitness changes, which can guide make individual exercise training plan for health improvement.

#### **EFFECTS OF 4 WEEKS OF MAXIMUM LIPID OXIDATION RATE INTENSITY TRAINING AND RESISTANCE TRAINING ON ADIPOSE TISSUE DISTRIBUTION AND MORPHOLOGY OF OBESE YOUTH**

Zhang, L.

*China Institute of Sport Science*

Objective: Although many studies have found the usefulness of aerobic and resistance training in reducing body fat. But few studies was about maximum lipid oxidation rate (MLOR) intensity exercise, or has been compared its effect with resistance training. This study aimed to find out the difference of the effect between the 2 training approaches on reducing body fat when combined with same diet restrict

methods. Methods: 37 obese youth were divided into 2 groups: aerobic training group (AT, n=20, 10 male and 10 female, age 20.8±2.2 years, BMI 30.3±2.2 kg/m<sup>2</sup>, body fat percentage 38.7±5.6 %) and resistance training group (RT, n=17, 8 male and 9 female, age 20.7±1.5 years, BMI 30.1±2.4 kg/m<sup>2</sup>, body fat percentage 38.5±5.5 %). The experiment lasted for 8 weeks. Subjects were submitted to different physical training plus the same diet restriction during 1st-4th week and no intervention during 5th-8th week. The exercise forms in AT group included brisk walking, jogging and aerobic dancing. Personal MLOR point was detected by ergospirometry device. The exercise forms in RT group were resistance strength training. The exercise time for both groups was 1.5 hours per day and 6 days per week. The diet was based on every subject's own resting metabolic rate (RMR) which was measured by ergospirometry device. Besides RMR, parameters including height, weight, body composition by DEXA, and body girth by 3D scan device were measured in pre-training and at the end of the 4th and the 8th week. Results: (1) When compared with pre-training level, all parameters detected at the end of the 4th and 8th week decreased significantly (p<0.05/0.01). The scale of decrease in AT and RT groups were: BMI -8.22±1.95% and -7.72±1.70%, total fat mass (TFM) -19.89±7.69% and -18.36±6.18%, total lean body mass (LBM) -2.28±2.16% and -1.77±3.77%, arm fat mass (AFM) -22.04±9.36% and -16.30±8.45%, leg fat mass (LFM) -8.78±27.22% and -15.80±4.63%, trunk fat mass (TrFM) -21.97±9.68% and -20.04±9.03%, waist circumference (WC) -5.11±2.81% and -4.46±2.80%. However, between AT and RT groups, only the scale of decrease in AFM showed the trend of different (0.05).

## WALKING ENERGY EXPENDITURE AND RECOMMENDATION IN CHINESE ADULTS

Wang, H., Jiang, C.M., Xu, L.L.

*China Institute of Sport Science*

Introduction: Among all the activities, walking is regarded by public as the most common exercise. The purpose of the study was to measure walking-related energy expenditure during field testing, to identify step-rate cut-point associated with moderate and vigorous intensity, and to translate physical activity (PA) guidelines into walking goals for Chinese young adults, and to explore the application of walking recommendation in community. Methods: Design: Cross-sectional analytic study Participants: A sample of 226 Chinese adults (117 men, 109 women) with age from 30~60 yrs. volunteered to participate in the study. All Participants were recreationally active without orthopedic limitations, free of chronic diseases, not taking any medications that affect metabolism and non-smokers. All the participants completed four 6 min incremental over ground walking at different speeds of 3.8, 4.8, 5.6 and 6.4 km/h, respectively. Indirect calorimeter was used to measure energy expenditure at each speed. Receiver operating characteristic curves were used to determine the step-rate cut-points associated with moderate and vigorous intensity activity. Results: At the same walking speed, step counts per minute were higher in women than in men. No significant differences were found in VO<sub>2</sub> per weight (ml/kg/min) between women and men. Step-rate cut point associated with walking at 3 metabolic equivalents (METs) and 6METs were 110 and 130 step/min when analyzing men and women together. There were slight differences on the cut-points between women and men if data were analyzed separately. Discussion and Conclusion: In order to associate our step-rate cut-point with PA guideline, the minimum walking steps of 3300 steps daily for MPA were considered based on our study result. It should be emphasized that 3300 steps need to be taken above the basic number of daily steps. Recent study has reported the daily walking steps goal for American people is 8000 steps, derived from accelerometer data, but an earlier study reported 10 000 steps. Since people have different PA patterns, it is difficult to establish consistent total number of walking steps for everyone. Moreover, there is not a comprehensive walking recommendation if only walking steps is involved but not the intensity. Therefore, it is practical and useful to provide a general suggestion that how many extra steps individual needs to take above the daily activities and how fast to walk for health promotion. Specially, Chinese adult should walk at least 30 min with a minimal 110 steps/min, or 3300 steps or 2 km with the same step rate daily to meet PA guidelines. They will perform vigorous-intensity activity if 130 step/min is reached and this will provide more health benefit.

## PHYSICAL ACTIVITY AND SITTING - HEALTH PROMOTION INTERVENTIONS AT THE WORKPLACE.

Proper, K.

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Despite known benefits of physical activity, still an important proportion of the adult population is not sufficiently active. Physical activity and health promotion can be done in several settings, including the workplace. The promotion of physical activity in the working population is of particular importance considering the increased automation and technology, leading to a change in the nature of our work. In the last years, our work has changed from physically demanding to more mentally demanding requiring sedentary behaviours (sitting) rather than physical activity. Interventions through the workplace to promote physical activity and reduce prolonged sitting hours are thus necessary. There are several ways to promote physical activity and reduce sedentary behaviour in workers. In this presentation, different types of such health promotion interventions and their effects will be given. Examples of such interventions include individual counselling on physical activity, environmental interventions, or group-based exercise programmes. Next to effectiveness, the question is whether the employers return their money invested in these programmes. Based on our economic evaluations and systematic reviews, results on costs and benefits (return-on-investment) of workplace physical activity and health promotion interventions will be presented. In the implementation of workplace health promotion, ethical issues may arise because of different views of the stakeholders involved, such as employers, employees, or occupational physicians. Through focus group interviews, we explored the views of all stakeholders involved in worksite health promotion. This presentation will provide the results of the ethical considerations that resulted from the differences between the views of the stakeholders. References 1. Verweij LM, Coffeng J, van Mechelen W, Proper KI. Meta-analyses of workplace physical activity and dietary behaviour interventions on weight outcomes. *Obes Rev.* 2011 Jun;12(6):406-29. 2. Groeneveld IF, Proper KI, van der Beek AJ, Hildebrandt VH, van Mechelen W. Lifestyle-focused interventions at the workplace to reduce the risk of cardiovascular disease--a systematic review. *Scand J Work Environ Health.* 2010 May;36(3):202-15. 3. van Dongen JM, Proper KI, van Wier MF, van der Beek AJ, Bongers PM, van Mechelen W, van Tulder MW. Systematic review on the financial return of worksite health promotion programmes aimed at improving nutrition and/or increasing physical activity. *Obes Rev.* 2011 Dec;12(12):1031-49. 4. van Berkel J, Meershoek A, Janssens RM, Boot CR, Proper KI, van der Beek AJ. Ethical considerations of worksite health promotion: an exploration of stakeholders' views. *BMC Public Health.* 2014 May 16;14:458.

## Invited symposia

### IS-SH03 INTERNET OF SPORTS: AUGMENTING SPORTS TECHNOLOGY FOR PERFORMANCE AND PLEASURE

#### INTERNET OF SPORTS APPLICATIONS

Nylander, S., Tholander, J.

*Swedish Institute of Computer Science*

Mobile Life is doing research in "Internet of Sports", exploring how to design the next generation of services for sports and physical activity. A wide range of sensors for body metrics are available, and many consumer products for exercise and sports have been released in the past few years. At Mobile Life we have been looking at how we can use this technology to enhance the experience of doing sports and avoid reducing humans to data through studying people's practices around sports, and through a number of design projects and service prototypes. A closer look at how elite and recreational athletes use heart-rate monitors reveals many purposes beyond improving performance. Heart-rate monitors are also used as tools to get to know the body, learn how to calibrate exertion as well as improving the experience of exercise. In our design work on running and golf, we have aimed to support the experiential aspects in combination with improving performance.

#### GOLF DATA ANALYTICS

Johansson, U., König, R., Dahlbom, A., Riveiro, M., Brattberg, P.

*University of Borås*

This lecture will present work-in-progress from the Golf Data Analytics (GOATS) – project at the universities of Borås and Skövde, Sweden. The overall purpose of GOATS is to use machine learning and data mining techniques for analysis of swing and ball flight data in combination with high-resolution video. One high-level task is to discover patterns by modeling and analyzing golf swings from large and heterogeneous data bases. Specifically, a prioritized goal is to identify general, but non-trivial, differences in the swing between good and poor players. Another ambition is to establish a modern framework for combining quantitative data about swing and ball flight with video analysis in golf training and instruction. One example is to design a systematic approach to identifying (individually for each golfer) the most important areas for improvement. Naturally, combining video and quantitative data allows a more advanced analysis, compared to using just video, but this requires new paradigms and innovative supporting tools for the golf instructor. In the talk, we will present data-driven models, found from a completed study with more than 300 golfers of different levels, describing the most important differences between highly-skilled and recreational golfers. We will also show some initial results from utilizing the Kinect sensor as an affordable alternative to more costly 3D-modeling tools. Finally, we will briefly describe future work in the project.

#### INTERACTION IN MOTION

Marshall, J.

*University of Nottingham*

Over the last 10 years, there has been a big increase in use of commodity technology to track and support sports activity. For example the wide range of sensors embedded in a modern smartphone means that these devices can support a wide variety of sports activities, and have the potential to go far beyond the current focus on quantity and distance of running and cycling. In particular the ability to sense form and identify the quality of movements means that cheap, widely available technology could be used for skill learning and improvement. This has potential to massively increase access to high quality skill learning for amateur athletes who are largely un-coached. However, this is fundamentally hampered by a major design assumption inherent in current technology, which is that it is not designed to be actively used while moving. Instead, it is designed around a 'stop to interact' paradigm, where any time users want to actively control the system, they must stop and look at a screen. In general this causes serious problems when users attempt to interact with technology whilst they are actually moving (see [1] for a more general analysis of these problems), but it is particularly problematic for sports interaction, where users are often more constrained than in normal usage situations. Touchscreen interfaces used on most mobile technology are inherently visual and lacking in spatial cues. Whilst various solutions to this have been presented, such as tactile displays and interfaces designed for purely audio and touch usage (e.g. [2]), they are both limited and specialised, so currently, the primary interaction method with mobile systems both requires looking at them, and touching them. When moving, particularly when doing sports, people are constrained in terms both of visual and mental attention and in their ability to physically touch user interfaces. If we are designing applications to be used during sports activities, we need to consider how we design for 'interaction in motion'. I propose 4 potential ways of designing taking movement into account: 1) Design with minimum interaction during the sporting activity, as is done by most current software. 2) Using interaction and user feedback at appropriate points in the activity (and sensing when they are). 3) Designing modified sporting activities which consider the technology being used to track them, such as targeted training sessions which are aware of when the user will be too busy to consider. 4) Interacting through sensing the activity itself. References [1] Marshall, J. and Tennent, P. Mobile Interaction does not exist, in CHI '13 Extended Abstracts on Human Factors in Computing Systems 2069-2078, ACM, New York, NY, USA, 2013 [2] Zimmermann, S., Rümelin, S., and Butz, A. I feel it in my fingers: haptic guidance on touch surfaces. In Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction (TEI '14). ACM, New York, NY, USA, 9-12, 2014

## Invited symposia

**IS-SH11 SPORT FOR DEVELOPMENT AND PEACE: critical perspectives****APPROACHING 'SPORT FOR DEVELOPMENT AND PEACE' AS AN INTER-DISCIPLINARY PROJECT**

Darnell, S.

*University of Toronto*

One of the features of recent research in the field of Sport for Development and Peace (SDP) has been inter-disciplinarity, with scholars from management, sociology, education and policy studies all asking important questions and producing significant findings and criticisms. While this trend illustrates the growing depth of the field, it also has the potential to create silos within the research community, particularly between a monitoring & evaluation (M&E) approach on the one hand, and critical analyses on the other. In this presentation, I attempt to reconcile these perspectives in productive ways. I suggest that M&E-focused research can inform a critical understanding of SDP by analysing the development effects of sport, both positive and negative. Vice versa, a critical sociology of sport-for-development – using, for example, macro theories of political economy and post-colonialism – can inform and improve SDP policy and practice by highlighting inequalities and challenging historical amnesia. Overall, I put forth that SDP, in both practice and research, is inextricably inter-disciplinary, and therefore scholars are charged with embracing multiple perspectives, rather than defending particular paradigms.

**MAKING TRANSNATIONAL, CROSS-CULTURAL CONNECTIONS IN SPORT FOR DEVELOPMENT AND PEACE: EXPLORING MULTI-SITED SOCIAL AND POWER RELATIONS**

Hayhurst, L.

*University of British Columbia*

Over the past decade, studies of Sport for Development and Peace (SDP) have examined programs through case studies of non-governmental organizations (NGOs), corporations, government agencies and international entities such as the UN. However, research into the SDP sector that engages with multiple stakeholders and global/local dynamics to examine how social relations among SDP actors influence and shape norms, policies and practices 'on the ground' remains mostly absent from existing studies. In this paper, I draw on multi-sited, transnational and cross-cultural empirical studies of SDP conducted over the past five years in order to highlight the importance of exploring complex social and power relations translated through diverse actors and contexts. Throughout this discussion, I consider the ways that global and cultural flows – and multiple connections – expand across transnational SDP and 'hold it together' against the diverse forces of disparate social locations, interests, identities and access to resources (see Thayer, 2010). In conclusion, I suggest that combining a multi-sited approach (e.g., Marcus, 1995) inspired by global ethnographies (e.g., Burawoy, 2001) that combine multiple geo-political perspectives (i.e. top-down and bottom up) provides new insights and meanings into the transnational nature of SDP studies. While studies of SDP-focused organizations in isolation of transnational forces are useful for providing in-depth accounts of policies, programming and impacts, I contend such studies potentially ignore crucial transnational, cross-cultural and postcolonial dynamics that influence these same issues. Overall, this perspective might also serve as a starting point for untangling the complexity of cross-cultural dynamics by focusing on SDP aid relations, its (un)intended effects, and the political rationalities and discursive relations that underpin it.

**LOCAL VOICES, SENSE-MAKING AND AGENCY IN THE 'UPTAKE' OF SDP PROJECTS IN AFRICA**

Burnett, C.

*University of Johannesburg*

Introduction Scholars are increasingly raising issues of complexity and contextual understandings of the multi-layered 'uptake' of Sport for Development and Peace projects in local settings. Positivist log frames often underpin donor dominated delivery models and translate in reductionist foci of indicator-driven impact assessments. Developing a body of knowledge from such research seldom transcends the mapping of the field. Critical reflexivity of unequal power relations, stakeholder dynamics and the 'uptake' processes of social learning should be considered in relation to delivery models and programme mechanisms. Utilizing a grounded theoretical approach in synthesis with critical conceptual frameworks seems crucial for theory building and social policy development. Methods The paper is based on secondary analyses of data from three different case studies, namely: i) the GIZ/YDF (German Development Corporation and European Union funded) programme in multiple African countries; ii) the Commonwealth Games Federation's internship programme in selected African countries. Results The 'uptake' differs according to the framework of proposed development (measured by indicators) in the GIZ/YDF programme where the main implementation was channelled through non-government partners (NGOs). On-site interviews of 11 international volunteer placements from Commonwealth Games Canada and representatives from the National Olympic Committees from different African countries, gave a rich view on the 'uptake' of such a programme. Discussion If SDP programmes provided insights into the partnership and stakeholder dynamics which are interpreted against a human justice framework and showing real-life experiences and exploitative practices. Understanding multiple perspectives and socially-engineered agency call scrutiny of critically pragmatic research practices that would reach beyond technocratic reporting to meaningfully contribute to academic discourses. Addressing the discourse of 'new colonialism' and 'pan-African paternalism' found special meaning in a partnership exchange with exploitative dimensions observed in 'non-indentured' programme outcomes. References Burnett, C. (2009). Sport-for-development approaches in the Southern African context: A case study analysis. *South African Journal for Research in Sport, Physical Education and Recreation*, 32(1):29-42. Césaire, A. (2000). *Discourse in Colonialism*. Translated by Joan Pinkham. New York: Monthly Review Press. Coakley, J. (2011). Youth sports: What counts as 'positive development'? *Journal of Sport and Social Issues*, 20(10):1-19. Coalter, F. (2013). *Sport for Development: What Game are we Playing?* London: Routledge. Darnell, S. C. (2011). Sport for decolonization: Exploring a new praxis of sport for development. *Progress in Development Studies*, 11(3): 183-96. Darnell, S. C., & Hayhurst, C. (2012). Hegemony, postcolonialism and sport-for-development: A response to Lindsey and Grattan. *International Journal of Sport Policy and Politics*, 4(1): 111-124.

## Oral presentations

### OP-PM39 Training & Testing: Endurance III

#### ECCENTRIC CYCLING WARM-UP AS AN ALTERNATIVE METHOD PRIOR TO A TIME TRIAL

Bosio, A.1, Ferioli, D.1, Induni, M.1, Morelli, A.1, Martin, D.T.2, Menaspà, P.2,3, Fell, J.4, Rampinini, E.1

1:Mapei Sport (Olgiate Olona, Italy), 2:AIS (Canberra, Australia), 3:ECU (Perth, Australia), 4:UTAS (Tasmania, Australia)

**INTRODUCTION** The warm-up characteristics can influence cycling time trial (TT) performance (Christensen and Bangsbo, 2014; Bishop, 2003). When compared to concentric (CON), eccentric (ECC) exercises are associated with a lower cardiovascular response for a given muscular strain. Therefore, the aim of this study was to test the effect of an ECC cycling warm-up compared to a conventional warm-up on cycling TT. **METHODS** After 6 weeks of familiarization to ECC cycling, 8 amateur cyclists performed a 5 Km TT on 2 separate days preceded by ECC or CON warm-up. ECC consisted of four 2-min bouts alternating low to high intensity ECC cycling (40% and 120% of aerobic PPO) on a custom-built ergometer preceded and followed by 6-min conventional cycling at 100W. CON consisted in 5-min light cycling followed by an 8-min ramped protocol progressively building intensity up to above the anaerobic threshold. Neuromuscular function (MVC and VA), lactate (La), creatine kinase (CK), pH, bicarbonate, heart rate (HR), RPE and muscle pain (MP) were quantified during the warm-ups. Power Output (PO), Cadence (CAD), HR and RPE were monitored during the TTs. **RESULTS** CK and pH were similar in the 2 conditions, bicarbonate was lower and La was higher after CON compared to ECC. HR and RPE were lower after the ECC warm-up ( $115 \pm 12$  bpm and  $2.8 \pm 0.3$  au) compared to CON ( $141 \pm 11$  bpm and  $3.9 \pm 1.2$  au). MP was similar in the 2 conditions (with a likely peak at the end of TT). TT performance ( $471 \pm 27$  and  $466 \pm 23$  s for ECC and CON respectively) was not statistically different ( $p=0.112$ ). RPE and HR increased similarly in the 2 conditions during the TT ( $p<0.001$ ). Pacing, as reflected by PO distribution, was negative (start hard, end easy); in spite of a significant interaction ( $p=0.037$ ) differences between conditions at the 500 and 2000 m mark were subtle. CAD was similar in the 2 conditions. MVC did not change during the entire duration of the experiment, while VA was on average lower during CON ( $p<0.05$ ). **DISCUSSION** It is likely that ECC cycling, as a form of warm-up, has the potential to be a viable alternative to conventional warm-up. In fact, ECC elicited lower cardio-circulatory, metabolic and perceptual strains than CON without compromising subsequent TT performance. Furthermore, some evidence suggests that ECC might prevent the onset of central fatigue despite the very high level of forces sustained during ECC compared to conventional cycling. Further research is required to understand the influence of ECC on pacing strategies. **REFERENCES** Christensen PM, Bangsbo J. (2014). Int J Sports Physiol Perform, [Epub ahead of print] Bishop D. (2003). Sports Med, 33(7), 483-98 Contact [andrea.bosio@mapeisport.it](mailto:andrea.bosio@mapeisport.it)

#### MONITORING HRV DURING REPEATED ELITE SWIMMING TRAINING-CAMPS

Ganzevles, S.P.M., de Haan, A., Beek, P.J., Daanen, H.A.M., Truijens, M.J.

VU University Amsterdam

**Introduction:** Heart Rate Variability (HRV) is a widely used measure to assess autonomic nervous system activity of athletes with the aim to optimize the individual training process. However, the underlying assumption that HRV provides an appropriate index of training load has not been tested to date, leaving the daily training practice without evidence basis (Koenig et al. 2014). In this study we monitored HRV in elite swimmers of the Dutch National team during their yearly training camp (TC) in January over the past three years. Although goals were similar over the years, i.e. enhancing aerobic condition, the specific implementation of training loads varied over the years. Therefore, we compared changes in training load with short-term (daily) and long-term (the complete training camp) changes in HRV. We hypothesized that changes in HRV parameters would reflect the variation in daily and weekly training load. **Methods:** Measurements took place one week before, during and one week after a three week TC in the same period of the swimming season over the course of three years. The same six swimmers participated in all three TC's. Measurements took place twice a week. The protocol consisted of lying in a supine position for 7 minutes in which beat-by-beat heart rate (HR) data were collected. Breathing frequency was controlled by a visual metronome at 0.2 Hz. From the HR data, HRV parameters were calculated for minute 2 to 6 (5 minutes in total). After normalization of the data, Pearson's correlation was determined between daily training load and HRV parameters. In addition, Pearson's correlation was determined for weekly training load and average HRV during one week. **Results:** We found no significant relation between daily training load and HRV parameters and between weekly training load and average week HRV. The highest correlation was found for weekly training load and RMSSD:  $r = 0.27$ ,  $p = 0.34$ ,  $CI = -0.65 - 0.96$ . **Discussion:** In contrast to commonly made assumptions, changes in HRV parameters did not reflect the variations in daily and weekly training load. This finding is in contrast with current literature on HRV. We conclude that it is unclear why HRV measurements should be incorporated in the daily training program of elite swimmers. **Reference:** Koenig, J., Jarczok, M. N., Wasner, M., Hillecke, T. K., & Thayer, J. F. (2014). Heart Rate Variability and Swimming. Sports Medicine 44(10):1377-91. doi:10.1007/s40279-014-0211-9.

#### VALIDATION OF A PROTOCOL THAT DETERMINES THE CAPACITY TO OXIDIZE FAT DURING EXERCISE IN OBESE ADULTS

Præst, C.1,2, Dandanell, S.1,2, Skovborg, C.1, Dela, F.1, Helge, J.W.1

(1.) University of Copenhagen (2.) Metropolitan University College

**Introduction** Achten et al. introduced a cycle ergometer test that determines the maximal whole body capacity to oxidize fat (MFO) and validated this in lean and well trained men by indirect calorimetry [1]. Interestingly a test modified and thus suitable for obese untrained individuals has not yet been validated. Therefore, the aim of this study was to validate a protocol that determines MFO and the relative intensity at which it occurs (Fatmax) in obese individuals. **Methods** Six overnight fasted subjects (3 W & 3 M; BMI:  $36 \pm 4$ ) performed two tests; a graded cycle exercise test (GE-test), starting at 30 watt for 6 min and increasing 20/25 watt/3 min in W/M, respectively. The test was stopped when the respiratory exchange ratio (RER) reached 1.0. On a separate day three 10-min bouts (CE-test) at 35, 50 and 65 % of  $VO_{2max}$ , interspersed with 30 and 40 min breaks, were performed. A Fatmax-curve was constructed from the GE-test and fat oxidation rates (g/min) were compared at the CE-test intensities using an Interclass Correlation Coefficient (ICC) 2.1 and a Bland-Altman plot with 95 % Limits of Agreement (LoA). **Results** A 2nd degree polynomial fit was used to estimate MFO and Fatmax in the GE-test ( $R^2 = 0.89$ ). Fatmax was reached at  $44 \pm 2$  % of  $VO_{2max}$  (range: 38-50). Despite a relatively good fit of the Fatmax-curve, as described above, the agreement between protocols was limited. The relative agreement was low (ICC: 0,331) and the absolute agreement, illustrated with a Bland-Altman

plot with 95 % LoA, indicated a large variation (LoA: +0.21 to -0.19 g/min). Discussion Based on the 6 subjects (out of 12) included in this ongoing study, the protocol using 3-min stages to determine MFO and Fatmax in obese individuals, showed limited validity. The lack of agreement between the two tests may be explained by 3 min being too short to reach steady state in obese untrained individuals [2] or it may be due to the small sample size. A more definitive conclusion of the validity of the 3-min stages protocol requires more subjects. References 1. Achten, J., M. Gleeson, and A.E. Jeukendrup, Determination of the exercise intensity that elicits maximal fat oxidation. *Med Sci Sports Exerc*, 2002. 34(1): p. 92-7. 2. Brun, J.F., A.J. Romain, and J. Mercier, Maximal lipid oxidation during exercise (Lipoxmax): From physiological measurements to clinical applications. *Facts and uncertainties. Science and Sports*, 2011. 26(2): p. 57-71. Contact c\_boslev@hotmail.com

### **INCREASES IN CIRCULATING CELL-FREE DNA DURING AEROBIC RUNNING EXERCISE DEPEND ON INTENSITY AND DURATION**

Haller, N., Tug, S., Jörgensen, A., Simon, P.

*Johannes-Gutenberg-University Mainz*

**Introduction:** Circulating cell-free DNA (cfDNA) is an upcoming molecular marker with a potential wide-range of applicability as a so called liquid biopsy in clinical diagnostics. Increases in cfDNA concentrations have recently been demonstrated to occur in a variety of exhausting and vigorous exercise settings. Here we assessed for the first time the effects of a moderate aerobic endurance exercise on cfDNA levels. **Methods:** 13 subjects (mean age: 24.38 years  $\pm$  2.90 years; mean height: 176 cm  $\pm$  10.06 cm; mean weight: 69.54 kg  $\pm$  12.22 kg) took part in our study, beginning with a step wise incremental test until exhaustion to determine their individual anaerobic threshold (IAT) (range: 10.8 km/h-13.4 km/h). Speed of the two endurance runs was set to 9.6 km/h for 40 minutes and therefore well below the IAT of all participants. Participants were dichotomized in two groups with above and below median (12.8 km/h) IAT. Capillary cfDNA, and rate of perceived exertion (RPE) by the Borg-Scale were assessed before, every 10 min during, and after the runs. **Results:** Lactate only increased significantly in the first minutes of the aerobic run in participants with a below median IAT remaining constant thereafter. In contrast steady increases for cfDNA during the endurance run and decreases after the run were observed for both groups. Significantly higher absolute concentrations and higher mean fold changes were observed for the group with below median IAT. Retest correlations for cfDNA were high ( $r=0.71$ ,  $p<0.0001$ ) for the whole collective, but even higher analyzing only male participants ( $r=0.84$ ,  $p<0.0001$ ). The correlation of cfDNA with RPEs were  $r=0.58$  ( $p < 0.0001$ ) and lactate values correlated moderately  $r=0.32$  ( $p < 0.05$ ) with RPE. **Discussion:** Both, duration and subjective level of intensity are associated with accumulation of cfDNA during a moderate aerobic running exercise. Along with a high test-retest correlation and a highly significant correlation with RPE indicated that cfDNA measurements might be applicable in the near future as a marker to estimate the individual level of exhaustion during aerobic exercise. This finding is surprising given that half of the participants were only exercising in a regenerative mode not showing increases in lactate above resting levels. The quite low intensity level applied in this study might have hampered higher correlations between RPE and cfDNA. Future randomized controlled longitudinal training studies will have to reveal the full potential of cfDNA as a marker in aerobic exercise settings.

### **MAXIMAL OXYGEN UPTAKE AND CARDIORESPIRATORY KINETICS BEFORE AND AFTER 6 WEEKS OF ENDURANCE TRAINING**

Drescher, U.1, Koschate, J.1, Scheffer, T.2, Brixius, K.2, Hoffmann, U.1

*German Sport University Cologne*

**Introduction** Endurance training improves the capacity and the regulatory responses of the cardiopulmonary and respiratory systems. To increase physical fitness, different training procedures (e. g. continuous, interval) can be applied. In this regard, diverse physiological adaptations of the training procedures have to be taken into account. Therefore, we were interested, whether six weeks of endurance training increases maximal oxygen uptake ( $\dot{V}O_{2max}$ ) and regulatory variables (cardiopulmonary kinetics) similarly. **Methods** Eight men (age: 43  $\pm$  9 years; height: 179  $\pm$  5 cm) performed pseudo random binary work rate (WR) changes on a leg cycle ergometer (30 W, 80 W) before (PRE; weight: 89.1  $\pm$  10.6 kg) and after (POST; weight: 89.2  $\pm$  8.8 kg) six weeks of endurance training. Four subjects were trained with a continuous (at 60% oxygen uptake reserve ( $\dot{V}O_{2Reserve}$ )) and the remaining four subjects with an interval (at 90%  $\dot{V}O_{2Reserve}$ ) intervention method, each three times a week. Heart rate was measured beat-to-beat via ECG, pulmonary oxygen uptake was determined breath-by-breath, and muscular oxygen uptake was estimated by the method of Hoffmann et al. (2013). Given a linear, time-invariant, first order system the peak of the cross correlation function (CCF) of work rate and a second parameter (heart rate, pulmonary and muscular oxygen uptake) indicates the kinetic responses of this parameter (Hpeak, Ppeak, Mpeak). Higher peaks denote faster system responses. Differences in the physiological variables between PRE and POST were statistically analyzed considering all subjects applying Wilcoxon's ranked samples test. The alpha level was set to 0.05 for statistical significance. **Results** Significant differences were found between PRE and POST in absolute  $\dot{V}O_{2max}$  (3.3  $\pm$  0.2 vs. 3.7  $\pm$  0.2 L $\cdot$ min $^{-1}$ ;  $p<0.05$ ;  $n=8$ ) and relative  $\dot{V}O_{2max}$  (37.5  $\pm$  4.8 vs. 41.2  $\pm$  4.1 ml $\cdot$ min $^{-1}$  $\cdot$ kg $^{-1}$ ;  $p<0.05$ ). No significant differences ( $p>0.05$ ) were observed in Hpeak, Mpeak or Ppeak. **Discussion** Six weeks of endurance training increases maximal oxygen uptake, but has no effect on the cardiorespiratory kinetics. However, analyzing the data of the two groups separately, continuous and interval training show contrary effects on cardiopulmonary and respiratory kinetics. The study was funded by the DLR (Deutsches Zentrum für Luft- und Raumfahrt), Germany (FKZ 50WB1426). References Hoffmann U, Drescher U, Benson AP, Rossiter HB, Essfeld D (2013). *Eur J Appl Physiol* 113:1745–1754.

## Oral presentations

### OP-PM71 Molecular Biology and Biochemistry: Metabolism

#### IMMUNE RESPONSE TO A SWIMMING SESSION DURING A 24-H RECOVERY PERIOD

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1-FMH, University of Lisbon, Portugal. 2-CIPER, FMH, University of Lisbon, Portugal 3-Unidade Laboratorial Integrada, Departamento de Promoção da Saúde e Doenças Crônicas, INSA, Lisbon, Portugal

Exercise immunology studies have shown convergent findings about total leukocytes, neutrophils, total lymphocytes, and monocytes response to exercise but lymphocyte subsets behavior has shown inconsistent results. Also, seldom real team training sessions have been studied. This study aimed to evaluate the acute systemic immune cell response to a real swimming session during a 24h recovery period, taking into account, sex, menstrual cycle phases for females, maturity and swimming age groups. Swimmers (30 females; 15+/-1.3yrs., and 35 males; 16.5+/-2.1 yrs.) performed a high intensity swimming training session (main set at 91.4+/-4.7 % of personal best time) at the end of the first macrocycle of the season. Blood samples were collected before (Pre), immediately after (Post), 2h after (Post2) and 24h after (Post24) exercise, by standard procedures for assessment of leukogram by automated counting (Beckman Coulter LH 750) and lymphocytes subsets by flow cytometry (FACS Calibur Becton, Dickinson and Company). Subjects were grouped according to the Portuguese Swimming Federation age groups, and monitored for pubertal Tanner stage, and girls for menstrual cycle phases. Statistical significance was set at  $p < 0.05$ . Only swimming age group influenced the response of neutrophils, total lymphocytes, and lymphocytes subsets CD3+, CD4+, and CD19+ to exercise. Monocytes and CD16+/56+ values were higher for males than for females at rest and along the 24h period. At Post, we observed neutrophilia, lymphopenia, reflecting the decrease of lymphocytes subsets CD3+, CD4+, CD8+, CD19+, and CD16+/56+, and low monocyte and eosinophil counts. At Post2, a delayed leucocytosis occurred and neutrophilia, lymphopenia, and low eosinophils count persisted, while monocytes and CD19+ had recovered to pre exercise values. At Post24, total lymphocytes and subset CD3+ maintained below pre-exercise levels in the junior group and all other parameters had fully recovered to baseline values, independently of the swimming group. These findings support the idea that a demanding swimming session, like other exercises, induces leukocytosis and neutrophilia and an acute depression of the acquired immune system lasting for at least 2h. This does not necessarily imply an enhanced immune response immediately after exercise followed by increased risk of infection or suppressed immunity. However, when considering the junior group, a 24h period may be insufficient to attain total recovery of the acquired immunity.

#### THE COL5A1 3'-UTR AND MUSCULOSKELETAL SOFT TISSUE INJURIES: A FUNCTIONAL STUDY

Collins, M., Laguetta, M.J., Prince, S.

University of Cape Town

COL5A1 encodes the  $\alpha 1$  chain of type V collagen, a minor fibrillar collagen that is an important regulator of collagen fibril assembly. Several polymorphisms, including rs12722 (C/T) within the 3'-UTR of COL5A1 is associated with chronic Achilles tendinopathy and other musculoskeletal soft tissue injuries as well as exercise-related phenotypes. It is hypothesised that polymorphisms within the 3'-UTR regulate synthesis of the  $\alpha 1(V)$  chain and type V collagen production thereby influencing the mechanical properties of musculoskeletal soft tissues. In our laboratories, two major functional forms, namely the T- and C-allelic forms, were identified and associated predominately with severe chronic Achilles tendinopathy and healthy asymptomatic control individuals. To further investigate the functional differences between the two major 3'-UTR functional forms as well as to start mapping the regions which are responsible for the tendinopathic phenotype, skin biopsies from donors having a known genotype at rs12722 and primary fibroblast cell lines were established in order to quantify COL5A1 and COL1A1 expression levels in a pilot study. Lastly, in preliminary RNA EMSAs, biotinylated C- and T-allelic RNA probes for a specific 57bp functional region within the 3'-UTR were incubated with either fibroblast nuclear or cytoplasmic protein extracts to investigate putative distinguishing RNA:RBP complex formation. An overall higher relative mRNA expression of both COL5A1 ( $p < 0.001$ ) and COL1A1 ( $p = 0.0015$ ) were observed in primary skin fibroblasts from donors having a rs12722 TT genotype compared to donors with a CC genotype. A unique RNA:RBP complex was also identified with the C-allelic probe. These novel results have important implications for our understanding of the proposed role of type V collagen in the aetiology of musculoskeletal soft tissue injuries and other exercise-related phenotypes. not insert authors here

#### PHYSIOLOGICAL PERFORMANCE AND BIOCHEMICAL PROFILE OF INDIAN ELITE FEMALE FOOTBALLERS DURING PRE-COMPETITION PHASE

Purohit, S., Medabala, T., Adhikari, S., Biswas, S.

Sports Authority of India, Netaji Subhash National Institute of Sports

**Abstract Introduction** Female football is one of the fastest growing sports in the world. There are, however, limited scientific data on how elite female players respond to the physical stress imposed by a football game. The game comprises activities like sprint and jumps in the attack as well as defense. Though, both aerobic and anaerobic capacities are very important to exhibit better performance, it is dominated by the aerobic capacity as the game lasts for one and half hour or even more (Malcovic et al., 1994). The evaluation of heart rate during games is very important to monitor the training load. Biochemical markers such as Lactate Dehydrogenase (LDH), Creatine kinase (CK), urea and uric acid (UA) are used for the evaluation of the physiological stress imposed by exercise. Increases in serum creatine kinase levels in response to strenuous exercise may be a consequence of both metabolic and mechanical stress (Brancaccio et al. 2007). **Methods** Twenty one elite Indian female football players were selected during the pre-competition phase. Peak and recovery heart rates were recorded during and after the game situations. Following overnight fasting blood markers of physical stress; creatine kinase and lactate dehydrogenase, urea and UA were measured. Results The results are expressed as mean  $\pm$  standard deviation. The mean peak heart rate recorded during training was  $186 \pm 13$  beats/min and during recovery it became  $157 \pm 16$  beats/min. The mean concentrations of the various biochemical parameter viz. LDH, CK, urea and uric acid were  $348.40 \pm 15.38$  U/L,  $143.71 \pm 52.63$  U/L,  $30.25 \pm 3.31$  mg% and  $3.61 \pm 0.68$  mg% respectively. **Discussion** This study was undertaken to examine the physiological performances and biochemical profiles of Indian elite female football players during the pre-competition phase. The mean peak heart rate was reported earlier as  $198 \pm 6$

beats/min in Sweden and Norway players having age of 27±1yrs (Andersson et al, 2008). Even though the mean peak heart rate for Indian players was relatively low as 186±13 beats/min, but the age group was studied varied 24±3 yrs. CK, LDH, UA and urea are the indicators of the physiological stress imposed by exercise. All the values after 12 hour of game situations came back with in the normal range, signifies better bodily response to the exercise. This preliminary result clearly indicates their ability for the adaptations were better during and after the game. References Andersson H, Ekblom B, Krstrup P. Elite football on artificial turf versus natural grass: movement patterns, technical standards, and player impressions. *J Sports Sci.* 2008; 26:113e22. Brancaccio, P., Maffulli, N. & Limongelli, F.M. Creatine kinase monitoring in sport medicine. *Br Med Bull.* 2007; 81-82, 209-230. Malkovic B.R., Jankovic S., Heimer S. Physiological profiles of top Croatian soccer players. In T. Reilly, J. Clayers & A. Stibbe (Eds.), *Science in football II* (37) 1994. (1st ed.). London: E & FN Spon.

#### VARIABILITY OF THE METABOLOMIC RESPONSE TO ENDURANCE EXERCISE IN MODULATED BY THE TRAINING STATE

Vaughan, D., Brogioli, M., Laczko, E., Flück, M.

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**Introduction** Exercise is a major stimulus for energy metabolism. Classical exercise biochemistry provided an initial description of the induced biomechanical pathways. A holistic picture of the metabolic processes being induced in exercised muscle, and the influence of inter-individual factors such as gene x environment interactions has not been carried out. We hypothesised that I) exhaustive exercise alters the abundance of a sizeable portion of molecular species in skeletal muscle and II) that this depends on the training state and angiotensin-modulated capillary supply lines. **Methods** Twenty-two 20-40 years-old, healthy volunteers were assessed for exercise capacity using ergospirometry (MetaLyzer 3B, Cortex) and for the ACE I/D polymorphism from muscosal DNA. After two days of rest and an overnight fast, subjects reported to the laboratory and carried out a bout of exercise with one leg (50% of maximal aerobic performance for 25 minutes, followed by a ramp composed of 10 Watt increments each minute) until exhaustion. Biopsies were collected from knee extensor muscle pre and 30 minutes post exercise and assessed for capillarity, glycogen content, and polar and non-polar metabolites using ultrahigh performance liquid chromatography – tandem mass spectrometry based on established protocols. Molecular species with pre-post changes were identified using statistical analysis of microarrays at a false discovery rate of 1%, mapped based on the exact neutral mass and the affected ontology (Progenesis Q1 - Nonlinear Dynamics) and explored statistically with principal component and cluster analysis (Statistica, Statsoft). Results 12 of 924 detected polar metabolites and 79 of 2059 non-polar metabolites were modified post exercise. Apart from a 2-fold reduction in the gold standard, glycogen, a number of novel metabolites from previously not identified ontologies associated with the metabolism of amino acids, prenol-, sterol- and sphingo-lipids, and food, were affected post exercise. Alterations of the muscle metabolome were explained by the training state, rather than capillarity and the ACE I/D gene polymorphism. **Discussion** The data point out that a relative short endurance stimulus induces a response of metabolite species that are not typically thought to be important for these types of stimuli. The identified influence of training state on muscle's metabolic response to exercise implicates that repeated muscle work alters the pool sizes of metabolic substrates. Contact [mflueck@research.balgrist.ch](mailto:mflueck@research.balgrist.ch)

#### AB-CRYSTALLIN MODULATION AFTER ACUTE EXERCISE IN SKELETAL MUSCLE: THE ROLE OF OXIDATIVE STRESS AND FIBER COMPOSITION

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**INTRODUCTION** αB-crystallin (CRYAB) is a member of the small heat shock proteins implicated in various biological processes, particularly in skeletal muscle where it is involved in adaptive remodelling processes and activation of gene transcription (Ito et al. 2001; Singh et al. 2007). We analysed αB-crystallin' response in mouse gastrocnemius after recovery from exercise, correlating its modulation with oxidative stress level and fiber composition. **METHODS** In vivo model: BALB/c mice of 3 weeks age were divided in two groups: Sedentary (S) and Exercised (EG, 15). The EG performed 1hr of aerobic exercise at 5.5m/min on a rotor and red gastrocnemius (RG), white gastrocnemius (WG) and soleus (SOL) were collected after 0', 15' and 30'. In vitro model: C2C12 myotubes were treated with hydrogen peroxide (H2O2) for 1 hr at 200μM and 300μM. After 0hr, 3hr, 6hr and 9hr of recovery time, stress proteins response (CRYAB, HSP70, HSP27), oxidative damage (carbonylated protein and 4-HNE), antioxidant proteins (TrxR1 and MnSOD), as well as survival and apoptotic pathways (p38MAPK, Caspase3, Akt, c-Jun, NFκB-p65 and NRF2) were evaluated in all samples. **RESULTS** While no increase in CRYAB protein level was observed, we clearly demonstrated that the acute exercise lead to a rapid, specific increase of phospho-CRYAB in the RG, but not in the WG. Moreover, this induction resulted correlated with increased levels of 4-hydroxynonenal (HNE), suggesting a putative role for exercise-induced oxidative stress in driving CRYAB, but not hsp70 or hsp27, activity. These data were also confirmed in the C2C12 in vitro model, where we detected a significant enhancement of pCRYAB in H2O2-treated C2C12 myotubes. Moreover, the specific inhibition of p38 activity was able to counteract the H2O2-mediated phosphorylation of CRYAB, confirming the involvement of this MAPK in the molecular pathway driving pCRYAB. **DISCUSSION** We demonstrated for the first time a fiber-dependent, p38MAPK-related role of CRYAB in the response of skeletal muscle to acute aerobic exercise. Further experiments are in progress to clarify both the molecular pathway driving CRYAB phosphorylation and its fiber-specific induction. In particular, we aim to identify the protein interactions to pCRYAB leading to the preservation of oxidative fibers' integrity and/or survival (Sakurai et al., 2005; Bullard et al., 2004). **REFERENCES** H. Ito, K. Kamei, I. Iwamoto, Y. Inaguma, K. Kato. (2001) *Expt. Cell Res.* B.N. Singh, K.S. Rao, T. Ramakrishna, N. Rangaraj, C.M. Rao (2007) *J. Mol. Biol.* T. Sakurai, Y. Fujita, E. Ohto, et al. (2005) *FASEB J.* B. Bullard, C. Ferguson, A. Minajeva, et al. (2004) *J. Biol. Chem.* [leisalillygrazioli@gmail.com](mailto:leisalillygrazioli@gmail.com)

### Oral presentations

#### OP-PM33 Sports Medicine & Orthopedics: Injury prevention I

##### MONITORING OF SPORT INJURIES IN YOUNG ELITE SOCCER PLAYERS

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**Introduction** Little information exists on the magnitude of injuries in elite development programs for young talented soccer players. The purpose of this study is to investigate the magnitude of the injury problem and to explore different monitoring methods. **Methods** During



a 5 month period (aug.– dec. 2014), 24 talented female soccer (mean age  $17.2 \pm 1.2$ ) players filled in the OSTRC Overuse Injury Questionnaire (Clarsen et. al. 2014) on a 2-weekly basis to monitor injuries. In this questionnaire, 4 questions are used to monitor the severity (range 0 – 100) of any physical problem. Subsequently, all players were asked to retrospectively report all time-loss injuries after the 5 month period. Results The response rate over the 5 month period for the online OSTRC questionnaire was 97%. A total of 256 questionnaires were filled in by all 24 players. Based on the OSTRC questionnaire, 63 injuries were reported. The most common localisations were ankle (18%), knee (14%) and the front side of the upper leg (14%). Most injuries were acute (76%) and 24% of the injuries was a re-injury. The duration of injuries ranged from 0 to 71 days, with a median of 2 days. In total, 17 time-loss injuries were reported. The most common localisations of the time-loss injuries were the ankle (29%), the knee (17%) and the back side of the upper leg (12%). Time-loss ranged from 9 to 65 days, with a median of 31 days. The total burden of each injury, calculated by summing the severity score for each 2-week period, was higher in time-loss injuries (mean = 185 vs 38). The sum of the severity score correlated significantly with the duration of the injury problems ( $r=0.91$ ,  $p<0.001$ ). The sum of the score of only the first question of the OSTRC questionnaire (the existence of health problems) also correlated significantly with the duration of the injury problems ( $r=0.91$ ,  $p<0.001$ ). Discussion The presented data show that many reported injuries do not necessarily lead to time-loss. This indicates that participation in training and matches with physical discomfort is common. Future studies may investigate the risk of physical discomfort on future time-loss injuries. Finally, simplifying the OSTRC questionnaire will benefit monitoring in a practical setting, especially with younger athletes. Our findings suggest that the first question of the OSTRC questionnaire is representative for the total injury severity. This result can form a starting point for further research on practical and valid injury monitoring tools. Contact a.richardson@hva.nl

### CAN MOTION CONTROL SYSTEMS PREVENT RUNNING-RELATED INJURY?

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**Introduction** A recent prospective study suggested that pronation is not a risk factor for running-related injuries (RRI).[1] Nevertheless, runners with pronated feet are usually recommended to wear shoes with motion control systems (MCS). Therefore, the aim of this study was to determine whether or not runners using shoes with MCS will sustain fewer RRI than runners using standard neutral shoes. **Methods** This double-blinded randomized control trial included 372 recreational runners. Foot morphology was analysed using the Foot Posture Index.[2] The participants were randomly allocated to either the experimental group (MCS) or the control group (STD). The only difference between the shoe models was the presence of MCS in the shoes distributed to the experimental group. Training and injury data were collected during 6 months on an internet based platform: www.TIPPS.lu. A RRI was defined as a physical pain or complaint, located at the lower limbs or lower back region, sustained during or as a result of running practice and impeding planned running activity for at least 1 day. Cox regression analyses were used to compare the occurrence of RRI rates between the two groups based on hazard rate ratios (HR) and their 95% confident intervals (CI). Stratified analyses were conducted to evaluate the effect of MCS in runners with supinated, neutral and pronated feet. **Results** 93 participants (25%) experienced at least one RRI during the observation period. The adjusted Cox regression analysis revealed that the runners from the MCS group had a lower hazard rate for RRI (HR=0.55; 95%CI=0.36-0.85). Previous injury was identified as a risk factor (HR=2.72; 95%CI=1.79-4.41), while running experience over the last 12 months (HR=0.91; 95%CI=0.84-1.00) and session distance (HR=0.91; 95%CI=0.84-0.99) were protective factors. When stratified according to foot morphology, results showed that only runners with pronated feet benefited from MCS shoes (HR=0.28; 95%CI=0.11-0.72). **Discussion** The MCS tested in this study was found to reduce the risk of RRI amongst runners with pronated feet. Further research should analyse if these results are generalizable and investigate what the underlying mechanisms are. **References** 1 Nielsen RO, Buist I, Parner ET, et al. Foot pronation is not associated with increased injury risk in novice runners wearing a neutral shoe: a 1-year prospective cohort study. *British journal of sports medicine*. 2014;48:440-7. 2 Redmond AC, Crosbie J, Ouvrier RA. Development and validation of a novel rating system for scoring standing foot posture: the Foot Posture Index. *Clinical biomechanics*. 2006;21:89-98. Contact Laurent.malisoux@lih.lu

### PARALYMPIC ATHLETES' PERCEPTIONS OF THEIR EXPERIENCES OF SPORTS-RELATED INJURIES: A QUALITATIVE STUDY

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**INTRODUCTION** Our knowledge of sports-related injuries in Paralympic athletes is limited (1), and there are no data on how the athletes themselves perceive an injury and how the disability itself influences their perceptions. The aim of this study was to explore Paralympic athletes' perceptions of their experiences of sports-related injuries. **METHODS** Eighteen elite athletes were recruited by a purposive sampling from the Swedish Paralympic program. Athletes with vision impairment, spinal cord injury, cerebral palsy, intellectual disability, myelomeningocele, dysplasia and neuromuscular disorders participated. They represented goalball, wheelchair rugby, athletics, cycling, skiing, boccia, ice sledge hockey, table tennis and swimming. Data were collected through individual interviews. For the detection and interpretation of the athletes' perceptions of their experiences a qualitative phenomenographic design was used. **RESULTS** The analysis revealed eight different categories of the perception of the experiences of the cause of a sports-related injury. The athletes perceived that the disability itself influences the cause and impact of an injury. Another perception was that the impact of elite training was seen as a cause of injury, and this may be explained by the inability to train correctly. Also, a majority of the athletes perceived that injuries could be self-inflicted. The domain to this category was described as one's own performance and the essence as guilt. Other categories identified were: the normalized pain, the impact of injury, individual possibilities to prevent injuries, the dangerous elite sports and the unequal prerequisites. **CONCLUSION** The results from this study indicate that Paralympic athletes' perceptions of their experiences of sport-related injuries are complex and multifactorial. This needs to be considered in the design of future injury surveillance systems and prevention programs. Also, these perceptions need to be taken in account in the sports safety work within the National Paralympic Committees to be able to secure a safe future sports career for Paralympic athletes. **REFERENCES** 1. Fagher K & Lexell J, Sports-related injuries in athletes with disabilities, *Scand J Med Sci Sports*. 2014 Oct;24(5):e320-31 **CONTACT** kristina.fagher@med.lu.se

## A MULTIFACTORIAL INJURY PREVENTION PROGRAM IN PHYSICAL EDUCATION TEACHER EDUCATION STUDENTS: PROCESS EVALUATION USING RE-AIM

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**Introduction** Efficacy of a multifactorial injury prevention program delivered through physical education teacher education (PETE) sports lecturers in PETE students has been proven in terms of injury incidence (Goossens et al., 2015). To describe further implementation possibilities, a process evaluation is requisite. Therefore, this study aimed to evaluate the feasibility of this multifactorial injury prevention intervention in PETE programs. The study aimed to determine both the proximal effects of this researcher delivered intervention on self-reported behavior, autonomous motivation and knowledge of PETE sports lecturers acting as intermediary delivery agents, and the more distal effects on self-reported behavior, autonomous motivation and knowledge of their PETE students. **Methods** A randomized trial was conducted in curriculum managers, sports lecturers and students from PETE programs in Flanders. A multifactorial injury prevention intervention ran during one school year. The curriculum managers and sports lecturers delivered the multifactorial injury prevention intervention: an injury awareness program and the implementation of prevention strategies in the sports lessons. A process evaluation was conducted using RE-AIM. Changes in self-reported behavior, autonomous motivation and knowledge were measured through questionnaires. **Results** The study had a good reach at setting (57%), staff (58%) and student level (59%). In sports lecturers, there was a trend to significantly greater increase in the intervention than the control group for the delivery of dynamic stabilization and functional strengthening and the weekly registrations revealed significantly more implementation of static stretching, dynamic stabilization and core stability in sports lecturers of the intervention group. In students, there was a significantly greater increase for knowledge in the intervention group. Adoption was very high. Implementation of the prevention strategies was high, but implementation of the posters and hand-outs was low. Maintenance in terms of intentions was reasonable on all levels. **Conclusion** A multifactorial injury prevention intervention for PETE students is feasible to a large extent. With only a very limited researcher delivered intervention, some effectiveness was found in sports lecturers and students. Future researcher delivered interventions should put emphasis on the importance of high implementation of an awareness program in order to achieve behavioral change in the targeted health beneficiaries. **References** Goossens L et al. A multifactorial injury prevention intervention reduces injury incidence in Physical Education Teacher Education students. *EJSS*—Accepted February 1st, 2015 Contact lennerf.goossens@ugent.be

## Oral presentations

### OP-PM48 Training & Testing: Agility

#### EFFECTS OF VISUAL TRAINING ON DECISION-MAKING AND REACTIVE AGILITY IN ADOLESCENT FOOTBALL PLAYERS

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**Introduction** Perceptual cognitive skills in team sports have been described as key-components for successful players. These skills include fast and accurate decision-making. This study investigated the trainability of these skills via video-based visual training as well as the transfer to a reactive-agility sprint test in young athletes. **Methods** 34 members of a national football academy (age:  $14.4 \pm 0.1$  y) were randomly assigned to a training- (VIS;  $n = 18$ ) or a control group (CON;  $n = 16$ ). In addition to the football training, the VIS completed a video-based visual training twice a week over a period of 6 weeks. The visual training consists of 32 video sequences (approximately 10 sec) of one-on-one situations. Before the study, 12 amateur players were asked to record a total number of 800 videos with a helmet camera (GoPro HD Hero 2) worn by the forwards. The defenders were instructed to attack in one of four ways: Block Tackling, Sliding Tackling, Front- and Back-foot Side Tackling. Using the temporal occlusion technique, 8 videos of each defending category were randomly presented during visual training. During a 2-sec occlusion, the subjects must decide the direction the forward could successfully pass the defender. To assess anticipation and decision-making, the number of successful decisions and the response timing was measured with a video-based test (40 videos). Reactive agility was assessed using the sprint-test described by Sheppard et al. (2006). Statistical analyses were performed with a two-factorial ANOVA with group (VIS vs. CON) and time (pre vs. post) as model factors. **Results** VIS significantly improved the number of successful decisions ( $22.2 \pm 3.6$  vs.  $29.8 \pm 4.5$ ;  $p < 0.001$ ) and response timing ( $0.41 \pm 0.10$  sec vs.  $0.31 \pm 0.10$  sec;  $p = 0.04$ ). No significant differences were found for CON ( $21.6 \pm 4.2$  vs.  $23.3 \pm 3.8$  and  $0.43 \pm 0.09$  sec vs.  $0.45 \pm 0.08$  sec; both at  $p > 0.05$ ). There were significant main effects of the group for the video-based test ( $p = 0.003$ ). Reactive agility was significantly improved in the VIS ( $2.22 \pm 0.33$  sec vs.  $1.94 \pm 0.11$  sec;  $p = 0.002$ ) but not in the CON ( $2.16 \pm 0.24$  sec vs.  $2.09 \pm 0.14$  sec;  $p = 0.67$ ). No significant group effect was observed ( $p > 0.05$ ). **Discussion** Our results have shown that a video-based visual training improves the time to make decisions accompanied by an increase in successful decisions. The transfer to a field-based reactive agility test suggests, that such training can improve game performance. **Reference** Sheppard, J.M. et al. (2006). An evaluation of a new test of reactive agility and its relationship to sprint speed and change of direction speed. *J Sci Med Sport* 9 (4):342-349. Contact: alfred.nimmerichter@fhwn.ac.at

#### COMPLEX AGILITY PERFORMANCE ANALYSIS OF ELITE YOUTH ACADEMY SOCCER PLAYERS. AGE AND POSITION SPECIFIC ASSESSMENT.

Zalai, D., Safar, S., Holanek, Z., Halmaj, T., Kesedi, G., Csaki, I.

*Hungarian Football Federation*

**Introduction** In the 21st century soccer requires players to think and act with extreme speed both in the physical and mental performance. The players change direction several times and perform shorter and longer sprints in the game situations (Meckel, 2009). These abilities related measures are considered the most relevant objective soccer specific tests (Young, 1996). Agility is an effectively developing skill during competition season and coaches can actively integrate agility developmental exercises into their training (Jovanovic, 2010). The aim of this study was to identify how agility measures can be examined among elite youth soccer players. **Methods** Elite academy youth players ( $N=179$ ) were examined from three academies in Hungary (U16 to U21). We are used the international validated well-established Arrowhead Agility (AA), Illinois Agility (IA) and ZigZag (ZZ) tests. The players performed and completed all tests with and without a ball. **Results** ANOVA analysis showed significant difference between age-groups in the Arrowhead test, with and without a ball (AA right:

$F(3,154)=5,72, p<0,01$ ; AA left:  $F(3,153)=5,76, p<0,01$ ; AA right with ball:  $F(3,153)=2,78, p<0,05$ ; AA left with ball:  $F(3,153)=3,9, p<0,05$ ). There was also a significant difference between playing positions in the IA both with and without a ball (IA:  $F(5,152)=3,96, p<0,01$ ; IA with ball:  $F(5,152)=4,51, p<0,01$ ). There was a strong correlation between results in the ZZ test with and without the ball ( $r=0,949, p<0,01$ ) and between the AA with and without the ball to the left ( $r=0,729, p<0,01$ ) and right ( $r=0,632, p<0,01$ ). This was also a weak connection between the results of the IA with and without the ball ( $r=0,334, p<0,01$ ). Discussion We established through our research, that there is a correlation between every test result; however, this study has confirmed that the agility structure is much more complex when examined with and without ball performance. These results demonstrate that decision-making must be incorporated in agility training programs, include game specific quick reaction elements and anticipation, furthermore indicate that players technical skills and the agility performance are different. In soccer, most of total running distance is performed without the ball. The outcome of competitive game situations is dictated by player's specific skills in relation to fast change of direction and acceleration without the ball as well. References Jovanovic M, Sporis G, Omrcen D, Fiorentini F. (2010). *J Strength Cond Res*, 25(5), 1285-1292. Meckel Y, Machnai O, Eliakim A. (2009). *J Strength Cond Res*, 23(1), 163-169. Young W, Hawken M, McDonald L. (1996). *Strength Condi Coach*, 4(4), 3-6. Contact zalaidavid@yahoo.com

## ANALYSIS OF A KOMPLEX STRESS STRAIN DYNAMIC IN A TECHNIC COMPOSITORIAL SPORT

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Introduction Success in optimization of training processes in elite sports is only then achievable when it is possible to develop sport specific effective preparation models in the field of scientific accompanying training management (Hohmann 1986). Especially in technic sports high training loads and volumes are necessary to develop an optimal level of performance. But there is a thin line between success and overload or overtraining in these sports. Therefore the aim of this study was to analyse the stress strain dynamic during a competition orientated training phase. Methods In a single case study the training input and stress reaction of an athlete of the rhythmic gymnastic national team was analysed over 6 weeks including a world cup competition. Training load as a stressor was analysed by using an expert based categorical training documentation tool. Heart rate variability (HRV), resting pulse were measured by Pulse7©, subjective feeling by a borg scale (TQR), PH of urine, body weight, subjective burden of the training load as the resultant strain operationalized by a borg scale were measured daily, the recovery progress protocol (EVP) form Kellmann (2010) has been used weekly. Results Training consisted of 9577 min in the 6 weeks. 60% of this training was technical training. Athletic training was only 10% of the whole input. Comparing the total training load with the SDNN values of the HRV measurements it can be seen that a high volume training day is followed two days later by a deep point in the SDNN curve. Training load and EVP show opposite effects during the 6 weeks. Using a time series analysis shows a statistic relevant relation with the lag of one day between the training load and the SDNN value of the HRV and the TQR. Discussion According to Arvay and Hofmann (2001) it can be seen that the resetting process of the SDNN value as an indicator of recovery takes about one day. So this measurement can be used as a valid parameter for measuring the stress - strain values of an athlete. This can be confirmed by the measurements of TQR and EVP values. Conclusion Using the SDNN, TQR and EVP as strain parameters can be useful to scientifically analyse the sport specific training process in elite sports. References: Hohmann, A. (1986), *Leistungssport* 5, 5-10. Kellmann, M. (2010), *Scand. J. Med Sci Sports* 20, 95-102. Arvay S. & Hofmann, P. (2001), *Spektrum Sportwissenschaften* 13, 5-13.

## PHYSIOLOGICAL RESPONSES TO REPEATED SPRINT ABILITY TEST < 10X15 M> IN YOUNG BASKETBALL PLAYERS: THE EFFECT OF CHANGE OF DIRECTION

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Introduction Repeated sprint ability (RSA) has been studied with protocols using longer distance than 20 m for each sprint, whereas basketball players cover on average less than 20 m distance per sprint during match. Therefore, the aim of the present study was to examine the physiological impact of RSA 10x15 m straight-line (RSASL) or with change of direction (RSACOD, i.e. 10x(7.5+7.5 m)) in young national level basketball players. Methods Young basketball players (n=11, age 17.1 (1.0) yrs, body mass 76 (6) kg, height 184 (4) cm, body mass index 22.6 (1.8) kg.m<sup>-2</sup>, sport experience 6.9 (2.7) yrs, mean (standard deviation)) and a control group consisting of high-school athletes (n=7, 16.1 (0.7) yrs, 67 (6) kg, 177 (6) cm, 21.5 (1.0) kg.m<sup>-2</sup>, 7.7 (1.6) yrs, respectively) performed RSASL and RSACOD on a counter-balanced order. Sprints (timed by Brower photocells, USA) started every 30 s (active recovery) and there was 30 min break between RSA protocols; time variables were total time (TT), best time (BT) and fatigue index (FI). Countermovement jump (CMJ, Optojump, Italy) was tested before and after each RSA protocol. Heart rate (HR) was continuously monitored (Polar team2, Finland) during testing procedures. Results Compared with RSASL, TT and BT were worst in RSACOD (38.13 vs. 27.52 s and 3.67 vs. 2.66 s, p<0.001, respectively), whereas FI did not differ (3.8 vs. 3.5%, p=0.388). A 2x2 repeated measures ANOVA showed main effect of RSA on CMJ (pre-test vs. post-test, +1.8 cm, p=0.020,  $\eta^2=0.28$ ); there was neither main effect of RSA protocols (RSASL vs. RSACOD +0.7 cm, p=0.251,  $\eta^2=0.08$ ) nor an interaction between pre-post measurements and RSA protocols (p=0.578,  $\eta^2=0.02$ ). Compared with RSASL, RSACOD induced higher mean and peak HR responses (175 vs 172 bpm, p<0.001, and 185 vs 182 bpm, p=0.002, respectively). No statistical difference was observed between basketball players and control group neither for TT (27.98 vs. 26.80 s, +4.4%, p=0.149) and BT (2.71 vs. 2.59 s, +4.5%, p=0.157) in RSASL nor for TT (38.55 vs. 37.47 s, +2.9%, p=0.169) and BT (3.70 vs. 3.63 s, 1.8%, p=0.414) in RSACOD. Conclusions In conclusion, RSASL and RSACOD differed for time variables (TT and BT) and HR responses. Despite being non-significant, the trend that adding COD reduced the percentage differences in TT and BT between the two groups highlighted the role of sport specialization.

## EFFECTS OF PRACTICE AGAINST ELASTIC RESISTANCE ON JAB PUNCH PERFORMANCE

Suzovic, D., Markovic, P., Djuric, S., Kasum, G., Jaric, S.

*Faculty of Sport and Physical Education*

Introduction High performance of rapid open kinetic chain movements (e.g., kicking, throwing, hitting, or punching) are important prerequisite for success in various sports. The use of ERT methods for improving the kicking performance has been already recommended (Davies, 2003). The effects of elastic resistance training (ERT) on rapid movements conducted on Taekwondo competitors revealed the improvement in the leg kick velocity (Jakubiak and Saunders, 2008). The aims of the present study were to investigate the effect of ERT on the performance of jab punch, to explore the associated changes in movement kinematic and kinetic patterns. Methods The national level junior competitors in kick boxing, savate, and boxing (N=40; age 17.2±1.0 years; means ± SD) practiced jab punch against elastic

resistance for 15 minutes per day, 3 times a week for 6 weeks. Results The results revealed a marked increase in maximum jab punch velocity in all groups (6-11%; all  $p < 0.01$ ). This finding was associated with an increase in both the maximum velocity and displacement of the ipsilateral elbow, shoulder and, particularly, hip joint, while no change in the movement time was observed. ERT associated increase was also revealed in the agonist (7-11%, all  $p < 0.01$ ), but not antagonist muscle strength. Discussion We conclude that addition of a relatively small amount of ERT, because it requires only increased agonist activity, could be recommended for the purpose of improving the performance of punching and, possibly, other rapid limb movement even in high level athletes. Since the applied resistance acts as an antagonist per se (Hofman and Strick, 1993) the observed performance improvement could be partly based on increased strength of agonist muscles, as well as on increased motion amplitudes particularly regarding the pelvis movement. Acknowledgments This work was supported by a National Institutes of Health grant R21AR06065, and Grant from the Serbian Research Council (#175037). References Davies, J.G. Sport-specific training for martial arts. In: The scientific and Clinical Application of Elastic Resistance. P. Page and S.T. Ellenbecker, Eds. Champaign, IL: Human Kinetics, 2003. pp. 267-278. Jakubiak, N, and Saunders, D. The feasibility and efficacy of elastic resistance training for improving the velocity of the Olympic Taekwondo turning kick. *J Strength Cond Res* 22: 1194-1197, 2008. Hoffman, D.S., Strick, P.L. Step-Tracking Movements Of The Wrist; III. Influence Of Changes In Load On Patterns Of Muscle-Activity, *Journal Of Neuroscience*; Volume: 13 Issue: 12: 5212-5227, 1993.

## Oral presentations

### OP-SH07 Psychology (Mental health and stress)

#### **"FROM WORLD CLASS TO UNABLE TO SHOOT IN THREE ARROWS"- AN UNDERSTANDING OF THE PERSONAL EXPERIENCE OF 'TARGET PANIC' IN ELITE ARCHERS**

Clarke, P., Akehurst, S., Sheffield, D.

*University of Derby*

The yips are a psycho-neuromuscular movement disorder, which affects sports where fine motor precision skills are required for success. This results in a yips-affected athlete experiencing a range of physical (jerks, tremor, freezing) and psychological symptoms (self-consciousness, anxiety, embarrassment). In archery, these symptoms have been labelled target panic and have yet to be investigated in yips literature. The current study aimed to qualitatively explore the psychological experiences of target panic in elite archers. This approach allowed an unrestricted exploration into the concepts of target panic and the long term nature of the yips. Seven elite level archers (males  $n=3$ , females  $n=4$ ; Mage= 32, SD +/- 11.03) who have experienced target panic (including Olympic, World, European and Commonwealth medallists) took part in semi-structured interviews. In line with previous yips studies in cricket and golf (Bawden & Maynard, 2001; Phillipen & Lobinger, 2011), the archers' thoughts, feelings and emotions before, during and after their experience of target panic were explored. A thematic analysis revealed five main themes, consisting of 15 sub-themes. These included: perceived control (control over movement, commitment, conscious control), coping (rationalise, mental, technical), emotions (anxiety, fear and depression), negative mind-set (confidence, expectations, self-consciousness) and focus (intrusive thoughts, conscious effort, analytical). These findings support target panic as a sport-specific form of the yips. They also support previous findings in yips literature with regard to the role of focus, both internally (technique) and externally (self-consciousness). One novel finding of this study was the extent to which archers felt a lack of control over commitment to their decision-making, during their target panic experiences. This is particularly important as archers have a limited time period to release their arrows, so decision making is a key component for performance. This study also provides some insight into the important role psychological factors play in the onset, development and consequential outcomes of target panic symptoms. Moreover, findings reinforce that yips in sport share a number of similar characteristics to severe choking. References: Bawden, M., & Maynard, I. (2001). Towards an understanding of the personal experience of the "yips" in cricketers. *Journal of Sport Sciences*, 19, 937-953. Phillipen, P.B., & Lobinger, B.H. (2012). Understanding the yips in golf: thoughts, feelings and focus of attention in yips-affected golfers. *The Sport Psychologist*, 26, 325-340.

#### **MENTAL TOUGHNESS IN ELITE MUAY THAI**

Powell, A., Myers, T.D.

*Newman University Birmingham*

Introduction There have been suggestions that exploring Mental Toughness (MT) in sport using mainstream psychological theories is needed (Anderson, 2011). Following attempts to conceptualise MT in team sports using Personal Construct Psychology (e.g. Coulter et al., 2010; Jones, et al., 2014), this study explored MT in Muay Thai, an individual sport. Anecdotally, MT is perceived to be an important prerequisite for success at an elite level in Muay Thai. Therefore, the aim of this study was to explore constructs associated with MT and its development in Muay Thai from elite fighters and coaches. Methods The perceptions and experiences of MT in Muay Thai were gathered from a purposeful sample of elite Muay Thai fighters ( $n=6$ ) and coaches ( $n=3$ ) using semi-structured interviews in accordance with Personal Construct Psychology (Fransella et al., 2004). The data were transcribed verbatim and initially analysed using grounded theory analytical techniques in order to elicit constructs. Results The initial analysis resulted in a series of bipolar constructs. MT in Muay Thai was conceptualised as: physical toughness vs physical fragility; focus while experiencing pain vs distracted by pain; functional vs dysfunctional under pressure; self-belief vs self-doubt; high self-confidence vs low self-confidence in their preparation; and perceived high technical competence vs perceived low technical competence. The development of MT in Muay Thai was conceptualised as: engagement in challenging and adverse situations vs avoidance of challenging and adverse situations; exposure to a culture valuing and rewarding mental toughness vs exposure to a culture that does not value or reward MT; and supportive task oriented environment vs non-supportive ego oriented climate. Discussion The findings support some attributes identified in previous studies of MT, including the importance of physical toughness, self-belief, handling pressure, maintaining focus and resilience (Gucciardi & Gordon, 2008). In addition, Muay Thai athletes also considered confidence in preparation, remaining focused and being able to operate functionally when in pain, and perceived technical competence to be particularly important for MT in Muay Thai. Participants highlighted particular types of experiences and the formation environment as being crucial in developing MT in Muay Thai. References Andersen, M.B. (2011). *Mental Toughness in Sport: Developments in Research and Theory*. Routledge, Oxon, UK. Coulter, T. J., Mallet, C. J., & Gucciardi, D. F. (2010). *J of Sports Sci*, 28, 699-716. Fransella, F., Bell, R., & Bannister, D. (2004). *A manual for repertory grid technique*. Wiley & Sons. Chichester, UK. Gucciardi, D. F., & Gordon, S. (2008). *Mental Toughness in Sport: A Review of the Literature*. In: *Mental Toughness in Sport: A Review of the Literature*. Edited by D. F. Gucciardi & S. Gordon. London: Routledge.

ciardi, D. F., & Gordon, S. (2008). *Pers Constr Theor Pract.*, 5, 119-130. Jones, R. A., Mahoney, J. W., & Gucciardi, D. F. (2014). *Sport Exerc Perform*, 3, 1, 28. Contact Alexander.Powell@newman.ac.uk

## Oral presentations

### OP-SH19 Philosophy & Ethics I

#### WALKING ON THE EDGE? THE DEVELOPMENT OF TALENTED CHILDREN IN ELITE SPORTS

Pilz-Burstein, R.

*Sport Excellence Academies*

**WALKING ON THE EDGE? THE DEVELOPMENT OF TALENTED CHILDREN IN ELITE SPORT** Introduction Sport academies have been recognized as an effective model for developing talented children towards top achievements in the international sport arena. Yet the process of talent identification (Burgess & Naughton 2010), the age of integration, training procedures and competing schedules are not being controlled by any objective body. Discussion The costs-benefits of developing a young athlete in elite sport academies are of ethical significance and deserve special attention of a professional team. Athletes entering the academy at 12-13 years take this major decision early in life dreaming of 'gold'. They develop self-discipline and make a full commitment to this challenging journey. Each athlete chooses the platform that will provide him with the best conditions to meet his goal: a top professional team in sport, a high standard educational-social system, excellent medical support and the best training facilities. Yet, beside all of these advantages the cost of this unique process should be seriously reviewed: the unnatural decision of leaving home at this early age; focusing on one specific target with repetitive, monotonous training; and belonging to one specific group (Rutenfranz 1986) while eliminating other social activities which often lead to debilitating emotional problems. In addition, facing failure and success along this journey can be a positive experience that strengthens the child, but occasionally may lead him to give up and quit, resulting in a strong sense of frustration. All of these issues are ignored by the young athlete and should not distract him from his goals. But can we control the cost and benefits? Can we avoid physical and mental damage when, for example, participation in a critical competition contradicts health considerations? And finally, is our responsibility as professionals to assist the national sport bodies with their mission pushing the boundaries of our youngsters to the top in the international arena, or should we be committed to balance between the extreme demands and the long-term well-being of our children? Recommendations Optimizing the process of fostering young athletes in the academy model requires careful screening procedures focusing on the mental and physical readiness of the child. It needs routine, on-going holistic support: social-psychological-medical with special attention to critical episodes of failure and success. Ensuring careful consideration of all of these issues by coaches, families and the professional team, the development of young athletes in sport academies can be recommended as an effective way to achieve top performance, yet avoiding any harm to our highly motivated children. References Burgess DJ, Naughton GA(2010) *Int J Sport Physiol Perform*,5,103-116 Rutenfranz J(1986) *Pediatrician*,13(1),7-14 Contact rutpb@gmail.com

#### HORSE - THE INVOLUNTARY CONTESTANT?

Andersson, P.

*University of Gothenburg*

Introduction In equestrian sports, horses are used as essential parts of the sports – in daily training and at competitions as well. Traditionally, horses used as parts of sports, have not been questioned, though some contest rules have been changed from time to time for the sake of horse welfare and security. Nowadays, however, animal ethicists and various animal rights organizations formulate strong criticism of sports that benefits from horses, claiming that equestrian sports are nothing more than expression of human superiority and arrogance. Methods Literature study, and studies of internet-based debates between animal right activists and horse people, followed by ethical, philosophical analysis of the argumentations. Results Animal right activists introduce several interesting and provoking arguments and conceptual distinctions in the debate. Special emphasis is given to a distinction between animal right-thinking and animal welfare-thinking, and to a distinction between actual and symbolic damage as well. Discussion While philosophy – animal ethics – is almost silent about equestrian sports, animal rights movement is the more talkative. The arguments used by animal right movements are often inspired by philosophers such as Tom Regan (2001) and Peter Singer (1990), and the activists develop and clarify them at several interesting points (Jönsson, 2012). The study examines the animal rights movement's arguments in detail. What is clarified by the introduced distinctions, and what aspects do they fail to clarify? Furthermore, the study analyses how the relation between rider and horse is understood. In the animal right movement rhetoric, the relation seems to be nothing more than an unjustified power asymmetry, expressing human superiority over the subordinated horse. Using horses in sports is hence claimed to be a disrespectful exploitation of horses, and cannot be considered to be in the horses' interest, as the horses do not participate voluntarily. References Regan, T. (2001). *Defending Animal Rights*. University of Illinois Press. Singer, P. (1990) [1975]. *Animal Liberation*. New York Review Books. Jönsson, K. (2012) "Humans, Horses, and Hybrids. On Rights, Welfare, and Masculinity in Equestrian Sports" *Scandinavian sport studies forum*, volume 3.

#### SUBJECTIVITY AND THE BODY

Hogenova, A.

*Charles University*

This text discusses the transformation of the body from the validity of a thing to the validity of an object and the consequences of this transformation for human life and for sport. The subject-object figure of thought is the result of a Cartesian relationship with the world, which is the basis of current scientism. The body as an object transforms into a resource, it alienates itself. The Modern Age is the inauguration of a new role of subjectivity. The subject becomes the only source of truth to be asked for and accepted. It is certainty - certitudo. Everything must be perceived by the senses, everything must be felt, seen, verified inter-subjectively. Falsification is a necessity in this day and age. Even with the body we seek only for what is verifiable by the senses. As is the case with all things around us, so it is with our body. We have lost the distance from things, which allows the "thinging" of a thing and we have turned things into objects that lie to against us, and so everything began with a subject-object figure, which is the basic structure of our relationship to the world. We live in a subject-object structure which determines everything, without us even particularly noticing it; this shows the blindness of modern man

with all his technical achievements. Even the body has become an object, an exclusive object; it has been reduced to a tool for amazing sporting achievements which the world demands from individuals. A jug is a thing only when we are able to see into the jug and understand the "poured gift". The water in the jug comes from heaven but it flows from a spring in the earth; however, it fell to the earth from heaven. Water connects heaven and earth, and we drink it as proof of this matrimony – a sacred game between heaven and earth - our foremothers. It is hieros gamos - the sacred game between heaven and earth, the sacred matrimony and invisible harmony, in which our lives take place. Such a harmony takes place between the body and the mind, the body is the earth and the soul is our own heaven. Exactly the same thing takes place during the Olympic Games, the clash of the athletes is captured by the formation of this perfect harmony between heaven and earth. Earth is represented by our bodies and heaven by the purity of agon, which is the same as the purity of the Olympic flame. The Olympic Games were never just about races where money was won, this is true for today as it is for the recurring final stages of the Olympic Games in the history of Europe. References: Heidegger, M. Der Anfang der abendlaendischen Philosophie. Frankfurt am Main: Vittorio Klostermann, 2012. Heidegger, M. Zur Sache des Denkens. Tuebingen : Max Niemayer 1969. Husserl, E. Vorlesungen zur Phaenomenologie der inneren Zeitbewusstseins. Freiburg 1928. Husserl, E. Analysen zur passiven Synthesis. (1918 – 1926). Denn Haag : Martinus Nijhoff, 1966, herausgegeben von Margot Fleischer. Merleau-Ponty, M. Phaenomenologie der Wahrnehmung. Berlin: Rudolf Boehm 1960. Contact: hogen@volny.cz

## NOVEL SPORTS MEDICINE TREATMENTS AND THE PLACEBO EFFECT: ETHICAL, EPISTEMOLOGICAL AND SOCIAL ISSUES

McNamee, M., Coveney, C.M., Gabe, J., Faulkner, A.

*Swansea University*

Introduction In elite sports, there is a potentially conflicting duplex of medicine and science in the treatment of injured athletes. Not only is there a conflict between long and short-term player welfare, but the evident commercial and competitive pressures that drive novel treatments whose evidence base is often less than robust. The aim of this study was to explore the ethical, epistemological and social issues that attend novel treatments in football medicine. Methods Our data are qualitative in nature, drawn from semi-structured interviews held with physiotherapists and doctors with experience of working in the English Premier league, high profile sports physicians and surgeons (n= 18). These explored the structure and composition of sports medicine departments, the most prevalent forms of novel treatments used, and the justification thereof in terms of ethics and evidence. Data were analysed using a thematic approach to identify topics and issues of significance. Analysis was facilitated using the qualitative analysis software program NVivo 10. Results The size of medical departments ranged between 6-15 persons, whether full or part time. Some were physio-led teams, others physician-led. The three most popular novel treatments were actovegin, platelet-rich-plasma therapy (PRP), and prolotherapy, while PRP the most frequently used among them. Discussion The rationale for using each of the treatments was heterogeneous. Evidentiary bases for them are not supported strongly by randomised control trials. Only PRP among them has been subjected to RCTs, yielding indifferent results (Engerbretsen, 2010) and with limited professional support (de Vos, 2010;). The justification for their use was based variously on clinical judgment, subjective experience, and validation or provenance from respected actors in their medico-"sportsnet"(works) (Nixon, 1993). These notions were compounded by player desires under conditions of partial consent, pressures from agents and coaches, and the complex use of placebo, whose application is ethically ambiguous. References De Vos, R. et al (2010) Platelet-rich plasma injection for chronic Achilles tendinopathy: a randomized controlled trial. *Jama*, 303(2), 144-149 Engerbretsen, L. (2010) IOC consensus paper on the use of platelet-rich plasma in sports medicine, *Br J Sports Med* 2010;44:1072-1081 Nixon, H. L (1993) Accepting the risks of pain and injury in sport: mediated cultural influences on playing hurt, *Sociology of Sport Journal*, 10: 183-96.

**18:00 - 19:30**

## Oral presentations

### OP-PM66 Nutrition: Clinical

#### DECREASED ENERGY AVAILABILITY DURING INTENSIFIED TRAINING INCREASES SIGNS OF OVERREACHING AND IMPAIRS MENSTRUAL FUNCTION IN COMPETITIVE FEMALE RUNNERS

Schaal, K., Hausswirth, C., Van Loan, M., Le Meur, Y., Casazza, G.

*University of California, Davis*

INTRODUCTION: Athletes training for endurance sports expend a very large amount of energy on a daily basis, and maintaining energy balance (energy intake – energy expenditure) can prove challenging, particularly during periods of high training volume. The suppression of ovarian function as a result of energy deficiency has been well studied, and is frequent among runners. Furthermore, it is likely that energy deficiency would also decrease the athlete's resilience to periods of training overload, predisposing them to excessive, training-induced fatigue (overreaching, OR). The study aimed to quantify the changes in energy balance of well-trained female runners during a period of training overload, and to test the hypothesis that failing to maintain a positive energy balance would increase the likelihood of developing both OR and menstrual disturbances. METHODS: 14 runners were recruited. After 1 full menstrual cycle of baseline training (P1), the training load was increased by 30% for 28 days (P2, starting on day 1 of the next menstrual cycle), followed by a taper period, reducing the training load to 50% of Baseline (P3). For 7 days during each phase, exercise energy expenditure (ExEE) was measured (Actiheart), and energy intake (EI) recorded. Running performance (distance covered on treadmill during a graded running test) was assessed at the end of each phase, together with perceived fatigue (Profile of Mood States), to diagnose each athlete as OR (high perceived fatigue and decreased performance) or not fatigued (NF) at the end of P2. Using urinary luteinizing hormone kits and menstrual cycle logs, a cycle was characterized as normal if: ovulation occurred, the luteal phase was > 10 days, and the cycle was < 35 days. Core temperature was assessed at the end of each phase. RESULTS: Upon completing P2, 6 were OR, and 8 runners were NF (Δ performance P2-P1: -10±5% vs +7±4 %). At the end of P3, performance was still suppressed in OR (-8±% from Phase 1), indicating a non-functional OR type. Energy balance decreased significantly in OR from P1 to P2, but not in NF (-5.6 ± 3.9 vs +1.6± 2.7 kcal/kg LBM/d), due to a failure to increase EI (+0.4±5.0, vs 4.0±2.5 kcal/kg LBM/d for NF) despite the increase in ExEE. Overall energy balance was negative in OR only (-7.9±4.4 kcal/kg LBM/d). A subset of 10 runners displayed normal menstrual function at P1. Of these, all 6 AF athletes maintained normal

menstrual function through P2, while 3 of 4 OR athletes displayed abnormal cycles (2 anovulatory, 1 short luteal phase). Core temperature decreased significantly for OR, but not AF ( $-0.5 \pm 0.2$  vs  $-0.2 \pm 0.2^\circ\text{C}$ ), possibly suggesting reduced progesterone production. **CONCLUSION:** This is the first prospective study, to our knowledge, to show that failure to increase energy intake and maintain energy balance during a period of heavy training significantly increases the risk of developing non-functional OR and menstrual disturbances.

### **A ONE YEAR STUDY OF DAILY DISTRIBUTION OF CALORIES AND BODY COMPOSITION CHANGES IN A GROUP OF MODERATELY ACTIVE PEOPLE**

Ghiani, G., Marongiu, E., Melis, F., Sanna, I., Pinna, V., Palazzolo, G., Crisafulli, A., Tocco, F.

*University of Cagliari*

**Introduction** It is well known that an active lifestyle and good eating habits are major components of a healthy lifestyle. It is also known that, to achieve a good nutritional status, along with a proper quantity of calories the nutritional value of meals is crucial. Garaulet and Gómez-Abellán (2014) show that a rich breakfast can influence overall daily food intake and weight loss in humans. Despite this fact, the typical Italian breakfast is inadequate, providing less than the 20% of the total daily energy intake. The aim of this study was to check whether a proper diet with a rich breakfast, providing the 30% of daily needs, could have a positive impact on the body composition of a group of moderately active people during one year follow up. **Methods** 32 moderately active, normal weight subjects (average Physical Activity Level  $1.7 \pm 0.2$  average Body Mass Index  $23.9 \pm 2.8$ ) participated in the present study. They followed a personalized diet for one year and were asked not to change anything in their lifestyle with the exception of the diet. To assess their energy expenditure, each of them wore a SenseWear Armband (SWA) for 48 hours (Casiraghi et al. 2013). They also attended an interview about their usual diet. Then, a proper diet was provided, both in terms of calories and nutrients. The given diet provided 30% of total daily intake at breakfast, that was different from their usual one, which provided less than 20% of total daily intake. For each subject fat mass (FM) was detected by means of plicometry method (Durnin and Womersley, 1974) at the beginning of the study (T0) and at the 6th (T6) and 12th (T12) month after T0. **Results** Data collected from SWA emphasized that their daily energy requirements was on average  $2652 \pm 470$  Kcal/day. After starting the diet, participants reported a better feeling of wellness, and their FM was significantly reduced from T0 ( $12.7 \pm 4.7$  kg) to T6 and T12 ( $10.5 \pm 4.01$  and  $10.9 \pm 4.0$  kg respectively,  $p < 0.05$ ). At the same time, they significantly gained free fat mass (FFM) from T0 ( $54.5 \pm 10.5$  kg) to T12 ( $56.6 \pm 11.2$  kg,  $p < 0.05$ ). **Discussion** The present data suggest that a high-intake breakfast diet can easily induce positive adjustments of body composition in moderately active healthy people. Skipping breakfast is to be considered an unhealthy habit and should be avoided. Further investigations are needed to better clarify this concept. **References** Garaulet M, Gómez-Abellán P. (2014) *Physiol Behav*, 134,44–50 Casiraghi F, Lertwattanarak R, Luzi L, Chavez AO, Davalli AM, Naegelin T, Comuzzie AG, Frost P, Musi N, Folli F. (2013) *PLoS One*, 19, 8(9):e73651 Durnin JV, Womersley J (1974) *Br J Nutr*, 32,77-97

### **EFFECT OF CAFFEINE SUPPLEMENTATION ON METABOLISM AND PHYSICAL AND COGNITIVE FUNCTION IN FEMALE INTERMITTENT GAMES PLAYERS**

Ali, A.

*Massey University*

The aim of this study was to investigate the effects of caffeine ingestion on metabolism and physical and cognitive performance in female team-sport players taking monophasic oral contraceptives of the same hormonal composition. In a randomised, double-blind, placebo-controlled crossover design, 10 healthy participants (age  $23.6 \pm 4.1$ y; height  $1.62 \pm 0.06$ m; body mass  $59.7 \pm 3.5$ kg;  $\text{VO}_2 \text{ max}$   $50.0 \pm 5.3 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ) completed a 90 min intermittent treadmill-running protocol twice, during days 5-8 and 18-22 of their pill cycle. During the familiarisation session participants completed a maximal oxygen uptake test, practiced the cognitive, perceptual, mood, strength and jump tests and underwent 30 min of the running protocol. Upon arrival at the laboratory for the main trials, hydration status was measured via urine specific gravity (USG) using a handheld refractometer and a heart rate (HR) monitor fitted. A capsule containing 6 mg·kg<sup>-1</sup> body mass (BM) of anhydrous caffeine or placebo (Maltodextrin, 1.62 kJ·g<sup>-1</sup>) was administered 60 min before commencing exercise with a 500 ml bolus of water. Further 3 ml·kg<sup>-1</sup> BM boluses of water were provided every 15 min during exercise. Before, during and after the exercise protocol, venous blood samples were taken and cognitive (Choice Reaction Time, CRT; Digit Vigilance, DV; Stroop test), perceptual (Ratings of Perceived Exertion, RPE; Feeling Scale, FS; Felt Arousal Scale, FAS; Profile of Mood States, POMS), and physical tests (countermovement jump, CMJ; strength testing on the isokinetic dynamometer) were administered. These tests were repeated  $12 \pm 2$  h post-exercise, and an assessment of sleep quality was conducted using the Leeds Sleep Evaluation Questionnaire (LSEQ). Plasma caffeine concentration was significantly higher in the caffeine trial and peaked 100 min after ingestion. Paraxanthine and theophylline levels were significantly elevated at  $12 \pm 2$  h post-exercise with no differences in theobromine. There were no significant effects of caffeine supplementation on HR, USG, CMJ, isometric strength, RPE, cognitive performance or glucose and insulin concentrations. Caffeine supplementation improved levels of pleasure (FS), activation (FAS) and vigour (POMS) compared to placebo ( $P < 0.05$ ) with a tendency for reduced levels of fatigue (POMS). Caffeine supplementation also improved average torque in eccentric contractions of the knee extensors and flexors, and peak torque in the eccentric contractions of the knee flexors ( $P < 0.05$ ). Getting to sleep and subsequent quality of sleep was impaired following caffeine supplementation ( $P < 0.05$ ). Free fatty acid (FFA) concentration increased over the duration of exercise ( $P < 0.05$ ), and increased at a greater rate on the caffeine trial ( $P < 0.05$ ). In conclusion, caffeine ingestion showed improvements in some strength indices but no improvement in cognitive performance in this cohort. Perceptual and mood responses were also improved as a result of caffeine supplementation.

### **THE EFFECTS OF 14-DAYS OF CREATINE SUPPLEMENTATION ON CREATINE PHOSPHATE LEVELS IN MUSCLE AND BRAIN IN YOUNG AND OLDER SUBJECTS**

Berk, E., Glover, E., Miller, S., Newbould, R., Parkin, J.

*GlaxoSmithKline and Imanova Centre for Imaging Sciences*

Creatine supplementation has been demonstrated to improve muscle energetics but the mechanism and on-set of the benefit is not well known. We performed a randomized, double-blind study of the effects of 14-day creatine supplementation on creatine phosphate (CrP) levels in muscle and brain using phosphorus-31 magnetic resonance spectroscopy (<sup>31</sup>P-MRS) in 15 healthy young male recreational athletes (Group 1, mean age  $26.7 \pm 4.8$  years) and 15 healthy older subjects (Group 2, mean age  $59.3 \pm 5.2$  years). In each cohort, 10 subjects took a creatine supplemented protein drink twice daily (total/day 10 g creatine, 60 g whey protein), and 5 took a control product (total/day 10g placebo, 60 g whey protein). Subjects took the product for 14 days and complied with a structured exercise intervention

program (3x/week). Serial static measurements were taken for muscle CrP (Days 0, 3, 7 and 14) and brain CrP (Days 0 and 14). Additionally, dynamic measures of muscle activity were assessed using a standard pedal test while subjects were in the MRI scanner. Within both groups, static levels of CrP were similar at baseline. By Day 7 the CrP supplemented individuals had significantly greater muscle CrP levels compared to the protein alone group (Group 1,  $43.87 \pm 4.34$  vs.  $38.31 \pm 4.52$  (mM);  $P=0.029$  and Group 2,  $41.93 \pm 3.98$  vs.  $38.14 \pm 1.96$  (mM);  $P=0.003$ ) and continued to increase and remain significantly higher at Day 14 (Group 1,  $44.04 \pm 4.74$  vs.  $37.80 \pm 5.62$  (mM);  $P=0.024$  and Group 2,  $45.03 \pm 4.77$  vs.  $38.36 \pm 3.01$  (mM);  $P<0.001$ ). Likewise the % change in brain CrP was significantly greater to the protein alone group at Day 14 (Group 1,  $6.30 \pm 7.36$  vs.  $-0.78 \pm 2.92$  (%);  $P=0.01$  and Group 2,  $8.45 \pm 6.92$  vs.  $0.83 \pm 1.16$  (%);  $P=0.0035$ ). For the pedal test, the subjects were instructed to perform a standardized routine to exhaustion; however we observed an inconsistent adherence of non-exhaustive to exhaustive exercise for all subjects across the multiple visits. As a result, there is limited interpretation of the data towards exercise related changes in CrP, ADP,  $T_{1/2}$  of CrP and  $T_{1/2}$  of ADP, and pH, yet some significant trends are observed within the two week timeframe. This study demonstrated that within 7 days (muscle) and 14 days (brain) both healthy, young recreational male athletes and healthy older subjects significantly increased their CrP levels with a 10 grams/day of creatine supplementation regimen. As a result, this study increases our understanding of the onset of the effects of creatine supplementation. Clinical Trial Registry #NCT02058654 Contact: evan.s.berk@gsk.com

### THE EFFECTS OF OMEGA-3 POLYUNSATURATED FATTY ACID SUPPLEMENTATION DOSE LEVEL ON HYPERPNOEA INDUCED BRONCHOCONSTRICTION SEVERITY AND AIRWAY INFLAMMATION IN PHYSICALLY ACTIVE ASTHMATICS

Williams, N.C., Johnson, M.A., Sharpe, G.R., Hunter, K.

*Nottingham Trent University*

High dose omega3-PUFA supplementation reduces airway obstruction and inflammation in asthmatics with HIB [1] but such doses are costly and may cause gastrointestinal side effects. The optimal dose level of omega3-PUFA for alleviating HIB is yet to be determined, therefore, the aim of the current study was to investigate the effectiveness of a lower omega3-PUFA dose on HIB and markers of airway inflammation. Eight asthmatics with HIB ( $\geq 10\%$  fall in forced expiratory volume in 1 s [FEV1] after eucapnic voluntary hyperpnoea [EVH]) and 8 non-asthmatic non-HIB controls were studied. Participants received, in a counter-balanced order under double-blind conditions, one of the following interventions for 21 days (each separated by a 2 wk washout): a) 6.2 g.d-1 of omega3-PUFA (8 omega-3 capsules containing a total of 3.7 g EPA and 2.5 g DHA) b) 3.1 g.d-1 of omega3-PUFA (4 omega-3 capsules containing a total of 1.8 g EPA and 1.3 g DHA + 4 placebo capsules) c) Placebo (8 placebo capsules of medium chain triglyceride per day) At day 0 and day 21 of each intervention, participants underwent EVH for the assessment of HIB, and neutrophil phospholipid fatty acid content was assessed from a venous blood sample. Asthma participants provided a pre-EVH fraction of exhaled nitric oxide (FENO) sample. Asthma and control participants provided urine samples before and 12, 60, and 90 min post-EVH for the assessment of eicosanoid 9a,11b-PGF2. No changes were observed after placebo. Conversely, the post-EVH  $\% \Delta FEV1$  had improved by  $\sim 35\%$  from  $-28 \pm 18\%$  and  $-28 \pm 17\%$  at day 0 to  $-19 \pm 15\%$  and  $-18 \pm 14\%$  following the 6.2g.d-1 and 3.1g.d-1 omega3-PUFA interventions, respectively ( $p<0.05$ ); these changes were not different between doses. Both omega3-PUFA interventions equally reduced resting FENO ( $\sim 30\%$ ) and day 21 post-EVH urinary 9a,11b-PGF2 concentration ( $p<0.05$ ). Both omega3-PUFA interventions reduced ( $\sim 9\%$ ) the pre-EVH arachidonic acid content, and increased EPA ( $\sim 75\%$ ) and DHA ( $\sim 15\%$ ) content of the isolated neutrophils ( $p<0.05$ ). All changes after both omega3-PUFA interventions were different compared with placebo ( $p<0.05$ ). This study shows for the first time that 3.1g.d-1 of omega3-PUFA is as effective as a much higher dose in attenuating HIB and markers of airway inflammation in physically active asthmatics. This lower dose represents a potentially beneficial management strategy for physically active asthmatics suffering with HIB whilst reducing the financial cost, compliance issues and potential for gastrointestinal distress associated with higher omega3-PUFA doses. 1. Mickleborough et al. (2006). *Chest*, 129(1):39-49

## Oral presentations

### OP-PM18 Physiology: Cardiovascular I + ESSA-ECSS exchange

#### CARDIOVASCULAR DIFFERENCES DURING ACTIVE VERSUS PASSIVE RECOVERY IN ICE-HOCKEY MEASURED USING IMPEDANCE CARDIOGRAPHY

Burr, J.1, Slysz, J.1, Boulter, M.1, Fowles, J.2

1: *University of PEI (Charlottetown, Canada)*, 2: *Acadia University (Wolfville, Canada)*

Introduction Competitive and recreational ice hockey is a popular sport in North America, Europe and many parts other parts of the world. Although the specific demands of ice-hockey differ somewhat according to the level of play, ice hockey is characterized by high-intensity exercise interspersed by periods of seated inactivity (Cox et al., 1995). Light activity during recovery has been demonstrated to improve the power output observed during repeated sprint activities (Connolly et al., 2003) and compared to passive rest, offers the potential to augment venous return and consequent cardiovascular function (Takahashi et al., 2005). Such alterations have implications for high level athletes and aged recreational participants alike. Therefore, the purpose of our study was to examine the efficacy of light intensity lower body exercises (standing and pacing) on the player's bench for altering hemodynamic function following a simulated on-ice hockey shift. Methods Young, healthy hockey players ( $n=15$ ,  $23 \pm 1$ yr,  $54 \pm 3$  mL.kg<sup>-1</sup>.min<sup>-1</sup>) were recruited to perform two simulated hockey shifts in a randomized cross-over design. During each on-ice trial, participants skated up to 85% of age predicted heart rate maximum, followed by either passive or active recovery while haemodynamic measures were tracked from cessation of work through 180s of rest. Results Even while wearing full hockey gear within the confines of an ice-hockey bench, light active recovery in the form of standing and pacing was effective for augmenting cardiac output at 45, 50, and 120s (an average of  $2.5 \pm 0.2$  L/min,  $p=0.03$ ). These alterations were consequent to a trending increase in stroke volume (11.6 mL,  $p=0.06$ ) coupled with a sustained elevation in heart rate (12 bpm,  $p=0.05$ ). Discussion Standing and pacing between shifts offers a realistic in-game solution to help slow the precipitous drop in cardiac output (heart rate and stroke volume) that typically occurs with seated passive rest. Prolonging the duration of elevated cardiac output further into recovery may be beneficial for promoting recovery of the working skeletal muscles and also avoiding venous pooling and reduced myocardial perfusion (Connolly et al., 2003; Franklin. 2005). This could have important implications for high-end sport performance or amongst participant with underlying vascular disease that have an increased risk of an ischemic event during high intensity



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### FOREARM MUSCLE BLOOD FLOW AND DEOXYGENATION DURING DYNAMIC HANDGRIP EXERCISE IN LIMB SPECIFIC TRAINED ATHLETES

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**Introduction** Rock climbers and oarsmen are frequently exposed to quasi-isometric or dynamic contractions of forearm muscles. Only limited information is available about vascular and muscular responses in the forearm during exercise in limb specific trained athletes. The purpose of this study was to investigate forearm blood flow (FBF) and deoxyhemoglobin and -myoglobin (deoxy[Hb+Mb]) in these limb specific versus non limb specific trained populations during a reliable incremental cyclic contraction protocol (ICCP)[1]. It could be hypothesized that, due to limb specific training adaptations, FBF and deoxy[Hb+Mb] will be higher in rock climbers and oarsmen compared to endurance runners and healthy control subjects. **Methods** 13 Belgian elite rock climbers, 13 oarsmen from the Belgian national squad, 13 high level endurance runners and 13 healthy control subjects, matched for gender, participated in this study. Before ICCP, maximal voluntary contraction (MVC) was determined for each individual, whereas FBF (in ml/min) and deoxy[Hb+Mb] (expressed in % towards the arterial occlusion maximum value[1]) were measured during ICCP using Doppler ultrasound (Doppler US) and Near Infrared Spectroscopy (NIRS). To determine efficiency, FBF and the highest deoxy[Hb+Mb] values (in %) were divided by force (N) for every step during ICCP. A repeated measures ANOVA was used to compare these parameters between the four groups. Results Absolute FBF was significantly higher for rock climbers and oarsmen during ICCP compared to endurance runners and healthy control subjects ( $p < 0.001$ ). When individual FBF values were divided by force (ml/min.N) for every step in the ICCP, oarsmen showed significant higher values compared to endurance runners and healthy controls ( $p = 0.001$ ). No significant differences were found between the different populations for relative deoxy[Hb+Mb] ( $p = 0.613$ ) and relative deoxy[Hb+Mb] normalized for individual force (%/N) ( $p = 0.191$ ) during ICCP. **Discussion** The higher FBF values in rock climbers and oarsmen compared to endurance runners and healthy controls can be explained by specific vascular and muscular training adaptations. The different response of rock climbers and oarsmen for the normalized FBF compared to endurance runners and controls, can be explained by a different cardiovascular strain as well as a different nature of forearm muscle contractions during specific rock climbing (quasi-isometric) and rowing (dynamic) training. The lack of significant differences in deoxy[Hb+Mb] between the 4 groups can be explained by the test protocol where relative deoxy[Hb+Mb] values were used.[1] 1. Celie B, et al. *Eur. J. Appl. Physiol.* 2012;112(6):2369-74.

### HEMOGLOBIN MASS IS DETERMINED BY LEAN BODY MASS IN YOUNG BOYS

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**INTRODUCTION:** In a homogenous group of endurance trained male athletes, hemoglobin mass (Hb-mass) was more related to lean body mass (LBM) than total body mass (Schumacher, Ahlgrim & Pottgiesser, 2008). Whether this is the case in children is unknown. The aim of the present study was to investigate if Hb-mass is higher in a group of boys with high VO<sub>2</sub>max (recruited from cross-country ski clubs) compared to a control group with lower VO<sub>2</sub>max. **METHODS:** Forty boys (age 13.4 ± SD 0.2) were recruited from cross-country ski clubs (XCS-boys) and 20 boys (age 13.5 ± 0.2) were recruited from a school. Hb-mass was determined using the optimized CO rebreathing method. VO<sub>2</sub>max was measured directly while running to exhaustion on a motor-driven treadmill. LBM was determined by InBody 720 bioelectrical impedance analysis. Differences between the schoolboys and the XCS-boys were assessed by Student's t-test for independent samples. Correlations between variables were assessed by Pearson's product-moment correlation. **RESULTS:** Schoolboys were 19 % heavier than the XCS-boys (53.2 ± 11.9 vs 44.9 ± 6.2 kg;  $p < 0.001$ ), while LBM was 9 % higher (44.6 ± 6.9 vs 40.9 ± 5.6 kg;  $p = 0.03$ ). There was no difference in body height (164 ± 9 vs 160 ± 9 cm). VO<sub>2</sub>max in absolute terms was similar between the two groups (2906 ± 410 vs 2920 ± 520 ml/min) while, relative to body mass, the VO<sub>2</sub>max in the schoolboys was 85% of that of the XCS-boys (55.2 ± 8.1 vs 64.8 ± 5.0 ml/kg min;  $p < 0.0001$ ). VO<sub>2</sub>max relative to LBM in the schoolboys was 92 % of the XCS-boys (65.4 ± 4.8 vs 71.2 ± 4.4 ml/kgLBM min;  $p < 0.0001$ ). Hb-mass relative to body weight was 6 % lower in schoolboys (10.3 ± 1.3 vs 11.0 ± 0.9 g/kg;  $p = 0.016$ ). However, when Hb-mass was normalised for LBM, there was no difference between the groups (12.1 ± 0.7 vs 12.0 ± 0.8 g/kgLBM;  $p = 0.81$ ). With the two groups pooled, the correlation between VO<sub>2</sub>max and Hb-mass relative to body weight was very high ( $r = 0.73$ ;  $p < 0.0001$ ) while the correlation was moderate ( $r = 0.31$ ;  $p = 0.02$ ) when VO<sub>2</sub>max and Hb-mass were related to LBM. **DISCUSSION:** The present data indicate that Hb-mass is determined by LBM in 12-13 year old boys. The higher VO<sub>2</sub>max relative to LBM in XCS-boys is not related to a higher Hb-mass since Hb-mass relative to LBM was similar between the groups. Also VO<sub>2</sub>max seems to be more related to LBM than total body mass, since the variation in VO<sub>2</sub>max relative to LBM was less than 50 % (SD 7 %) compared to the variation in VO<sub>2</sub>max relative to body weight (15 %). **REFERENCES:** Schumacher YO, Ahlgrim C, Pottgiesser T. *J Sports Med Phys Fitness.* 2008 Dec;48(4):509-14. Contact: Jostein Hallén. E-mail: jostein@nih.no

### POST-AEROBIC EXERCISE METABOREFLEX STIMULATION DELAYS HEART RATE RECOVERY

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**Introduction:** The role of metaboreflex on heart rate recovery after exercise (HRR) is controversial. Classic studies suggest no influence after handgrip exercise. However, it is speculated that this mechanism may be active after exercises with larger muscle masses. Thus, the aim of this study was to evaluate the influence of metaboreflex on HRR after aerobic exercise. **Methods:** 15 healthy middle-aged men (114 ± 6/77 ± 3 mmHg, BMI = 29 ± 3 kg/m<sup>2</sup>, VO<sub>2</sub>peak = 26 ± 4 ml.kg<sup>-1</sup>.min<sup>-1</sup>) randomly underwent 2 exercise sessions (cycle ergometer, 70% VO<sub>2</sub>peak, 30 min) followed by 5 min of inactive recovery. Recovery was performed with (occlusion session) and without (control session) leg circulatory occlusion (cuffs at the hips inflated to supra-systolic pressure). ECG was registered and HRR was assessed by: heart rate reduction after 60 (HRR60s) and 300s (HRR300s) of recovery; short-term time constant of HRR (T30); time constant of the HRR after exponential fitting (HRRt); and mean values of HR in segments of 30s (HR30s). Heart rate variability (HRV) was assessed by the root mean square residual (RMS) and by square root of the mean squared differences of successive R-R intervals (rMSSD), on subsequent 30-s segments. Paired T-test, Wilcoxon test and two-way ANOVA (session vs. time) were employed (Newman-Keuls post-hoc;  $p < 0.05$ ). **Results:**

HRR60s, T30 and HRR<sub>t</sub> were similar between the control and the occlusion sessions (26±9 vs. 24±9 bpm, p=0.30, 340±191 vs. 224±74 s, p=0.20; 79±33 vs. 40±30 s, p=0.18, respectively). HRR300s was significantly lower in the occlusion session (28±10 vs. 38±13, p=0.00). HR30s, rMSSD and RMS present significant time vs. session interactions, showing slower recovery of HR30s from 120s (106±10 vs. 99±13 bpm, p = 0.00), of rMSSD from 270s (1.2 ± 0.5 vs. 1.7 ± 0.7 ms, P=0.01) and of RMS from 180s (1.6±0.7 vs. 2.1±0.7 ms, P=0.01) in the occlusion session in comparison to the control session. Conclusion: In conclusion, metaboreflex stimulation during the recovery period of aerobic exercise delays HRR, particularly the slow phase of HRR. Funding: FAPESP 2013/044997-0 and 2013/05519-4

### EXERCISING OPPORTUNITIES TO PREVENT CHRONIC DISEASES: THE CAPO KIDS TRIAL [ESSA]

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**Introduction:** The increasing incidence of both chronic bone and obesity-related disease places a heavy burden on health economies. Both conditions may arise in childhood. While exercise in youth is beneficial for both bone and metabolism, the nature of exercise recommendations for each traditionally differs. **Aim:** Our goal was to determine the effect of a brief, novel, enjoyable, school-based exercise regimen targeting both bone and fat in primary school children. **Methods:** A controlled exercise intervention trial was conducted over a full school year (9 months). The intervention comprised 10 minutes of thrice-weekly capoeira and jumping activities. Anthropometrics, waist circumference (WC), calcaneal broadband ultrasound attenuation (BUA) and stiffness index (SI) (Lunar Achilles, GE), maximum vertical jump (VJ), cardiovascular endurance (predicted VO<sub>2</sub> max), resting heart rate (HR), blood pressure (BP) and maturity (YAPHV) were recorded at baseline and 9 months. A subset of whole body (WB), lumbar spine (LS) and femoral neck (FN) BMD, lean and fat mass (DXA, XR800, Norland), and indices of tibial and radial morphology and density (pQCT, XT3000, Stratec) was also collected. Changes in outcome variables were compared between groups using two-way ANOVA, controlling for YAPHV and initial values. Stepwise linear regression were performed to determine the relationships between bone parameters. **Results:** 296 children, including 130 control (CON) (10.7 ± 0.6yo; YAPHV -1.9 ± 0.9y) and 166 treatment (EX) (10.5 ± 0.5yo, YAPHV -2.1 ± 0.9y) participated. EX improved WC (EX: 1.95 ± 2.82 cm; CON: 4.09 ± 4.05 cm; p = 0.001), HR (EX: -4.11 ± 3.35 BPM; CON: 0.22 ± 3.8 BPM; p = 0.001), VJ (EX: 3.47 ± 4.01; CON: -0.59 ± 5.16; p = 0.001), predicted VO<sub>2</sub> max (EX: 2.68 ± 3.96; CON: -0.20 ± 3.38 ml/kg/min; p = 0.001), SI (EX: 6.25 ± 10.04%; CON: 4.09 ± 6.99%; p = 0.05) and BUA (EX: 3.99 ± 9.06 dB/MHz; CON: 1.33 ± 8.3 dB/MHz; p = 0.01) compared to control. Sex-specific effects largely mirrored those findings. Baseline BUA and maturity predicted 32.2% of the variance in BUA change (p = 0.001) for boys; while BMI and baseline BUA accounted for 16.4% of the variance in BUA change (p = 0.006) for girls. **Conclusion:** School-based capoeira with jumping improved markers of metabolic and musculoskeletal health in primary school children. The exercise program was safe, enjoyable and easily incorporated into the school schedule.

## Oral presentations

### OP-PM28 Sports Medicine & Orthopedics: Orthopedics II

#### RADIOLOGICAL STUDY OF CHANGES IN MUSCLE VOLUME USING MR IMAGING IN PATIENTS UNDERGOING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION OF THE KNEE WITH SEMITENDINOUS AND GRACILIS AUTOGRAFT

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**INTRODUCTION** There is still controversy with respect to muscle performance in association with muscle cross sectional area (CSA) in thigh musculature one year after original ACL reconstruction. **OBJECTIVE :** To analyze the cross sectional area (CSA) of quadriceps and hamstring muscles in a sample of 29 recreational athletes following two different rehabilitation programs: conventional (15, CG) and accelerated (14, AG), before and one year after having undergone ACL surgical reconstruction with autologous hamstring graft. **MATERIAL AND METHODS:** 29 athletes were exposed to MRI studies (1.5 TMagnetom Avanto; Siemens-Erlangen©, Germany). before and 12 months after ACL reconstruction. CSA was calculated (mm<sup>2</sup>), on Quadriceps (Q), Biceps femoris (BF), Semitendinous, (ST) Semimembranosus (SM) and Gracilis (GR) muscles, at 30, 50 and 70% of the femur's length level. The same surgeon (J.A.A) performed all the surgical interventions with standardized procedures. Isokinetic knee joint flexo- extension torque evaluations (N.m) (Cybex – Human Norm© CA. USA) were also performed in the same time points at an angular velocity of 180°/sec. T-tests of paired comparison (injured limb before and after 1 year from the reconstruction; injured limb vs. contralateral limb after 1 year from the reconstruction) and independent sample T test for inter-group comparison (healthy and operated limbs of both groups before and after surgical procedure) were made, setting the significance level at p < 0.05 (SPSS v. 17.0). **RESULTS:** Significant (p < 0.05) muscle CSA reductions (ST at 50% and GR at 70% levels in the reconstructed limb before and one year after ACL reconstruction) were observed in both treatment groups: [mean ± SD: ST: 861.9 ± 278.97 vs. 625.81 ± 208.35; 95% CI: 51.94 – 420.25 GR: 131.50 ± 87.76 vs 50.72 ± 79.90; 95% CI: 18.0 – 143.54 mm<sup>2</sup> ] and [ST: 807.62 ± 178.06 vs 630.56 ± 158.22; 95% CI: 46.20 – 307.91 GR: 165.24 ± 130.94 vs 53.13 ± 60.40; 95% CI: 29.56 – 194.64 mm<sup>2</sup> ] in CG and AG respectively. With respect to muscle isokinetic performance, subjects allocated in AG group, demonstrated significantly (p < 0.05) greater knee flexion torque in their reconstructed limbs in comparison to CG subjects [mean ± SD: 186.29 ± 37.96 vs 141.23 ± 34.79 N.m respectively] that were not present before ACL reconstruction [ mean ± SD: 142.38 ± 38.54 vs 141.95 ± 52.04 N.m for both groups respectively] **CONCLUSION** Objective atrophy of the implicated musculature (ST and GR) related to the surgical reconstruction present in both groups persisted in the reconstructed limb 1 year after ACL reconstruction. Surprisingly, subjects following an accelerated rehabilitation protocol exhibited greater muscle force despite persisting muscle size reduction. The results suggest possible neural drive optimization derived strength gains predominating in relation to function restoration in the harvested musculature. **REFERENCES.** Janssen.R et al. Knee Surg Traumatol Arthrosc (2013)

### MUSCLE FUNCTION AFTER ACL INJURY CAN PREDICT FUTURE SELF-REPORTED OUTCOMES

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1 Dept. of Health Sciences, Lund University, Lund, Sweden, 2 Dept. of Sports and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark. Introduction The long-term consequences of an anterior cruciate ligament (ACL) injury often include worse self-reported outcomes and a decrease in activity level. Muscle function, such as muscle strength, hop performance and postural orientation (the ability to stabilize body segments in relation to each other and the environment), is a modifiable factor which can be improved by targeted exercise. The association between lower extremity muscle function and later consequences of an ACL injury is poorly investigated. Aim To investigate the association between lower extremity muscle function and future self-reported outcomes after ACL injury. Methods Fifty-four patients, a subgroup from the Knee Anterior Cruciate Ligament, Nonsurgical versus Surgical Treatment (KANON) study, were assessed at mean 3 years (SD 0.85) after ACL injury or reconstruction with three hop tests (vertical jump, one-leg hop for distance and side hop), three muscle power tests (knee flexion, knee extension and leg press) and visual rating of Postural Orientation Errors (POEs) during performance of five functional tasks. POEs were determined as Knee Medial to Foot Position (KMFP) across the five tasks and an overall score for all tasks based on the orientation of several segments. Self-reported outcomes were assessed with the Knee Injury and Osteoarthritis Outcome Score (KOOS) subscales Function in sport and recreation (KOOS Sport/rec) and Knee-related Quality of life (KOOS QoL), the Knee Self-Efficacy scale (K-SES) subscore Present (K-SES Present) and Tegner Activity Scale (TAS) at follow-up 5 years after injury. Univariate linear regression analyses were used to test relations between muscle function and self-reported outcomes. Correlations with  $p$ -value  $<0.2$  were included in a multivariate regression model, adjusted for baseline scores, sex, age, body mass index and treatment. Results A worse overall score of POEs, and KMFP, was associated with worse K-SES Present at follow-up (unadjusted  $\beta$  -0.83 and -2.93, respectively and adjusted  $\beta$  -0.81 and -4.63, respectively,  $p \leq 0.002$ ). There were no associations between muscle function test scores and KOOS Sport/rec, KOOS QoL or TAS scores at follow-up ( $p > 0.081$ ). Conclusions Worse overall score of Postural Orientation Errors and Knee Medial to Foot Position at mean 3 years predict worse present self-efficacy of knee function at 5 years after ACL injury. This suggests that treatment should target exercises aimed at maintaining the ability to stabilize body segments in relation to each other and the environment, i.e., good postural orientation, to improve future self-efficacy of knee function in people with ACL injury.

### EFFECTIVENESS OF EXERCISE THERAPY COMPARED WITH STEROID INJECTION FOR LATERAL EPICONDYLITIS: A RANDOMIZED CONTROLLED TRIAL

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Effectiveness of exercise therapy compared with steroid injection for lateral epicondylitis: A randomized controlled trial Eqrem Gara, Ardiana Murtezani, Bekim Haxhiu, Arbnore Ibrahimaj, Zheraldin Durguti. University Clinical Center of Kosovo, Prishtina, Kosovo. Introduction Lateral elbow tendinopathy (LET) or 'tennis elbow' is a common disorder with a prevalence of at least 1.7%. Typical symptoms are pain at the lateral epicondyle of the humerus and pain on resisted dorsiflexion of the wrist. A wide variety of treatment strategies has been described. As of yet, no optimal strategy has been identified. Exercise therapy have been used either alone or in conjunction with physical interventions. Corticosteroid injection for LET may be beneficial but not well maintained. The aim of the study was to compare the effects of exercise therapy with local corticosteroid injections in the treatment of tennis elbow. Methods The study was a prospective RCT performed in the Physical and Rehabilitation Medicine outpatient department. At a first appointment the diagnosis was checked by pain on palpation, and Maudsley's middle finger test. Thirty-nine patients with lateral epicondylitis were randomly distributed into two groups as follows: exercise therapy group ( $n=20$ ) and injection group ( $n=19$ ). Exercise treatment consisted of progressive, slow, repetitive wrist and forearm stretching, muscle conditioning, and occupational exercise. Injection therapy consisted of a single injection of 10 mg of triamcinolone acetonide and of 2% lignocaine hydrochloride. The effect of eight weeks treatment was measured by a pain questionnaire (visual analogue scale), isokinetic muscle performance testing of wrist and forearm, and painfree grip strength measurements. All patients were evaluated before treatment and at the 8 week. Results Our results showed that after eight weeks of treatment there was a significant improvement in the entire group of patients but the corticosteroid injections were better than the exercise group. VAS values during activity and pain levels during resisted wrist dorsiflexion were significantly lower in Group II than Group I at the eight week ( $p < 0.001$ ). Discussion We conclude that at eight week, treatment with corticosteroid injections was more effective than exercise therapy. Current evidence suggests that corticosteroid injections offer the best prospects for short term relief of symptoms, and physiotherapy (perhaps the exercise component of physiotherapy) offers the best prospect for good long-term outcomes (Bisset et al., 2005) References Bisset L, Paungmali A, Vicenzino B, Beller E. A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. (2005). Br J Sports Med, 39:411-22 Barr S, Cerisola FL, Blanchard V. Effectiveness of corticosteroid injections compared with physiotherapeutic interventions for lateral epicondylitis: a systematic review. (2009). Physiotherapy, 95(4):251-265 Contact: ardianna@yahoo.com

### EFFECTIVENESS OF A MULTICOMPONENT APPROACH PROMOTING PHYSICAL ACTIVITY IN CHRONIC LOW BACK PAIN PATIENTS: SIX MONTHS FOLLOW-UP RESULTS OF A RANDOMIZED CONTROLLED TRIAL

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Introduction The promotion of health-enhancing physical activity (PA) is widely recommended to increase the sustainability of rehabilitation (Pfeifer et al., 2010). Hence, adherence to self-directed exercise and implementing health-enhancing PA into a daily routine following rehabilitation is a common problem for patients (Haaf, 2005). The aim of the present study was to estimate the effectiveness of a multi-component intervention (Movement Coaching) compared with a low intensity intervention (control group) in terms of promoting leisure time PA in chronic low back pain (LBP) patients. Methods The study was conducted as a two-arm randomized controlled trial including 412 patients. Measuring points were at the beginning of inpatient rehabilitation (T1) and at six months follow-up (T2). Three different outcomes were assessed: "MET-min/week during leisure time", number of patients "achieving WHO recommendations" and number of patients showing "any physical activity". Between-group differences at T2 were tested. Results The patients' mean age was 50.4 ( $\pm 8.1$ ) years, 286 patients were men (69%), and 86% reported duration of pain of more than twelve months. There were no significant differences between Movement Coaching and the control group in regard to effectiveness at T2. Although it was not significant ( $p = 0.21$ ), the Movement Coaching group showed tendentially a higher median (270 MET-min/week vs. 180 MET-min/week) and more patients

“achieving WHO recommendations” ( $p = 0.27$ ). In contrast, number of patients reporting “any physical activity” was higher in the control group ( $p = 0.86$ ). Overall, 84 % in the Movement Coaching group and 91 % in the control group did not achieve the WHO recommendations on PA during leisure time and therefore were classified “not sufficiently active” at T2. Discussion The evaluation underlined the assumption that chronic LBP patients in inpatient rehabilitation were an appropriate target group for PA promotion. Overall, the results of the present study broadly agreed with the current research that no superior intervention strategy or method could be identified. A noticeable aspect of the present study was that Movement Coaching and the control group tended to show different effects according to the PA outcome criteria assessed. In this context a cost-effectiveness study is planned to gain information for resource allocation. References Haaf, H.-G. (2005). *Die Rehabilitation*, 44(5), 259–276. doi:10.1055/s-0031-1291280 Pfeifer, K., Sudeck, G., Brüggemann, S., & Huber, G. (2010). *Die Rehabilitation*, 49(4), 224–236. doi:10.1055/s-0030-1261909 Contact a.schaller@dshs-koeln.de

### INJURY INCIDENCE AND INJURY PATTERNS OF ELITE-LEVEL MALE SOCCER PLAYERS IN KOSOVO

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Introduction Soccer players have a substantial risk of injury and teams that can avoid or minimise injuries have a greater chance of success. To establish prevention programs it is important to identify risk factors, to study injury patterns and to learn about injury incidence during match and training, respectively. The current study therefore aims to describe the incidence and nature of sport-related injuries in elite soccer players over a complete season. Methods Over the autumn and spring season 2013/2014 a total of 143 male players (age:  $23.2 \pm 4.1$  yrs.; body mass  $74.2 \pm 6.7$  kg; height  $180.0 \pm 5.0$  cm) were tracked. Players who volunteered for these studies were members of the highest league in Kosovo. Following a baseline data sampling during preseason team injury, training and match play data were submitted by the medical staff on a weekly basis using Injury Report Form (F-Marc) suggested by FIFA (Fuller et al., 2006). Results A total of 272 injuries occurred during 36,833 hrs of exposure giving an injury incidence of 7.4 injuries per 1,000 hrs. Injury incidence during matches was distinctly higher (35.3) than in training (3.1). The single most common injury subtypes were muscle strains (24%) and ligament injuries (21%), respectively. 63% of all injuries occurred during the match versus 37%, which occurred during training. Traumatic injuries comprised 71% of all injuries 29% were overuse injuries. Moderate injuries (causing absence of 8-28 days) accounted for 40% of all injuries. Discussion Injury incidence and injury patterns of the current study are largely in agreement with data from the UEFA injury study on professional players (Ekstrand et al., 2011). References Fuller et al., (2006). Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Scand J Med Sci Sports* 16: 83-92 Ekstrand et al., (2011). Injury incidence and injury patterns in professional football – the UEFA injury study. *Br J Sports Med*. 45(7): 553-8 Contact: ishalaj1@hotmail.com

## Oral presentations

### OP-PM44 Training & Testing: TeamSport II

#### AN EXPLORATORY STUDY ABOUT THE REACTION TIME IN HANDBALL GOALKEEPERS

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1:FADEUP (Porto, Portugal), 2:UM (Minho, Portugal), 3:FEUP (Porto, Portugal) Introduction It is commonly accepted that a successful performance in goalkeeping depend not only of efficient and accurate execution of movements to intercept the ball trajectory but also of the ability to read the thrower intention/actions and to react on time. The aim of this study was to investigate the whether the goalkeeper in a 7-meter throw can decide based only on the free ball trajectory or if it must include a heuristic reasoning based on the thrower traits and actions. Methods The sample consisted of 13 field players (6 best Portuguese senior females and 7 best Portuguese junior males) and 9 goalkeepers (5 male and 4 female). A set of three goalkeepers were evaluated per session. In each session there were two setups: a regular 7m throw – in an official court, with an official ball, standard illumination, etc. – and a blind setup were, at the 7m line there was an apparatus that did not disturb the thrower but did not allowed the goalkeeper to see the thrower/ball. Every 7m throw was preceded by a whistle signal, so the throw was taken within 3 seconds (like in a regular match). The sequence of trials – goalkeeper/thrower/setup – was completely randomized, with each player having between 1min and 5min intervals between shots. The scene was fully recorded with 3\*3 high speed video cameras (working at 200 fps in the visible range). Each goalkeeper was carrying a set of 6 wireless EMG sensors (biceps brachii, latissimus dorsi, gastrocnemius medialis) and 4 wireless three-axial accelerometers (wrists and ankles) sampled at 296 samples per second. All devices (cameras, EMG and accelerometers) were electronically synchronized i.e., shared a common time base. Main results and conclusions The results showed, as expected, that women shot at goal at lower velocities than men – a difference of about 25% in the ball’s velocity was found. In the other hand, the reaction times of male and female were found quite similar (almost within the experimental uncertainty). However, when the reaction time is exhausted, the ball has moved 2.5m (females) to 3m (males). It will reach the goal in about 0.4s (females) to 0.3s (males), and the body parts still need to move to the interception place. What is apparent from this experiment is that females have time to react to the real ball trajectory while men don’t, at least in the case of difficult shots. So men must speculate, from the movements of the thrower, what the balls trajectory will be, while women can probably guess less and react more. To have similar decision time than women, men must speculate and make a decision 60ms before the ball is launched. This is a huge time and in a fast throw coincides with the final launch of the arm. This is where the thrower’s deception strategies can be most efficient.

#### THE INFLUENCE OF DIFFERENT WORK AND REST DISTRIBUTIONS ON PERFORMANCE AND FATIGUE DURING SIMULATED TEAM HANDBALL MATCH PLAY

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INTRODUCTION: Team handball players evidence fatigue-induced decrements in high intensity activity from the first to second half of matches. Effective management of player work and rest periods during matches could help to minimise physiological loading and better

maintain performance. This study aimed to establish the effect of two different interchange strategies on performance and pacing strategy during a simulated team-sports protocol. METHODS: Eight outfield youth male team handball players (age:  $16.1 \pm 1.0$  y, stature:  $1.82 \pm 0.11$  m, body mass:  $69.3 \pm 6.6$  kg) completed two conditions of a team sport simulation. LONG comprised 3 x 13:00 min periods of work, separated by 8:00 min rest between activity periods. SHORT comprised 5 x 7:48 min periods of activity, separated by 3:45 min rest between work periods. Absolute work time (39:00 min) and rest (16:00 min) periods were the same for both conditions. Participants were tested for 20 m sprint, counter-movement jump and throwing performance during each condition, with heart rate being monitored continuously. Post-condition measures included Repeated Shuttle Sprint and Jump Ability, session rating of perceived exertion, blood lactate and blood glucose. RESULTS: Sprint time deteriorated progressively throughout the simulation ( $P = 0.005$ ), but overall faster sprint performance was apparent in SHORT ( $3.87 \pm 0.27$  s) rather than LONG ( $3.97 \pm 0.24$  s,  $P = 0.03$ ) by a 'likely small' difference. Throwing velocity revealed a 'likely small' difference that was indicative of better performance in SHORT ( $70.02 \pm 7.40$  km·h<sup>-1</sup>) compared to LONG ( $69.04 \pm 5.57$  km·h<sup>-1</sup>,  $P > 0.05$ ). There were no differences in throwing accuracy or counter-movement jump performance ( $P > 0.05$ ). Practically meaningful higher average heart rate ( $166 \pm 8$  b·min<sup>-1</sup> cf.  $169 \pm 9$  b·min<sup>-1</sup>) and summated heart rate ( $150 \pm 15$  cf.  $157 \pm 21$ ) were apparent in SHORT compared to LONG by a 'likely small' difference ( $P > 0.05$ ). Post-condition measures showed that SHORT resulted in 'most likely moderate' lower sRPE ( $224 \pm 45$  AU cf.  $282 \pm 35$  AU,  $P = 0.001$ ), in addition to 'most likely moderate' higher blood glucose ( $6.06 \pm 0.69$  mmol·l<sup>-1</sup> cf.  $4.98 \pm 1.10$  mmol·l<sup>-1</sup>,  $P = 0.03$ ) compared to LONG. However, there were no differences in blood lactate ( $P > 0.05$ ) between conditions. Repeated shuttle sprint running performance was also better preserved after SHORT work and rest periods, with 'moderate' decreases in 10 m and 25 m sprint times ( $P < 0.05$ ). CONCLUSIONS: Collectively, these findings suggest that interchange strategies using SHORT as oppose to LONG periods of work and rest result in overall lower physiological load that leads to improved fatigue resistance and a better preservation of high-intensity movements throughout a match. This information could prove valuable to maximise player performance both during a match and a tournament where multiple matches are played consecutively.

### PERFORMANCE DIAGNOSTICS, TRAINING LOAD AND RECOVERY ASPECTS IN MALE ELITE TEAM HANDBALL PLAYERS

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Introduction Team handball was undergoing severe rule changes in the last years and since then matches with 55 or more goals are often to be seen. We investigated a first division team over two years in motor performance and injuries and various data concerning their recovery status. Our goal was to achieve deeper insight in the interaction between performance, trainload and recovery. Methods N = 16 male elite team handball players (incl. 10 players of various national teams) participated in this study. Several parameters related to regeneration were analysed: body composition (via bio impedance), aerobic capacity (standard field test), sprint ability (2x5x30m sprint protocol) and force-resistance (series of jumps). Assessments were conducted in July before the pre-seasonal preparation period, in September after the preparation period, and in the half-seasons break (January). Results The players (N=16, average age 27,1 years and 192,1cm height) showed the following anthropometric data in the season: 95,6 kg weight, 10,4% body fat. Training load in the preparation period was 11 sessions/week (20h/w) and was reduced during the season to a weekly average of 7 sessions/week (12h/w) due to the energetic cost of the 52-60 matches the team players had to perform in the season 2013/14. Results revealed that handball players improved their aerobic capacity (+0,2 m/s to v14 4.2 m/s) and decreased average weight (-2,3kg) and body fat (-2,2%) during the preparation period and maintained those values until the winter break. Peak aerobic performance (v14 4.2 m/s, 3,9-4,4 m/s) was slightly better than compared to previous own findings from second division teams. Maximum sprint performance was 2.91 sec/30m (2,78-3,23 m/s) and like their sprint ability and force-resistance did not change significantly over the year. Discussion Despite the players' high level of motor performance and training quality, 33 injuries occurred, leading to six cases of severe injuries resulting in long term match absence. In elite team sports the level of fatigue, and the probability of injury are linked together. Despite a quantifiable improvement in the players' motor performance one may therefore assume that the quality of the human regeneration processes may dictate performance limits, and also the ability to maintain a healthy status. Resources may therefore mainly be found in optimizing the interplay between the total load and the recovery in each individual player. Further studies and tools are needed in this field. References unpublished studies from the authors (2006-2015) Contact knoeller@osp-niedersachsen.de

### DIFFERENCES IN GENERAL AND GAME BASED PERFORMANCE IN ELITE, HIGH EXPERIENCED AND EXPERIENCED MALE TEAM-HANDBALL PLAYERS

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Introduction Team-handball is an Olympic sport characterized by fast paced defensive and offensive action during a game. These actions include team-handball specific movements, fast accelerations and decelerations, changes of directions and frequent changes with low intensity movements. However, team-handball performance is mostly measured using standardized endurance, strength and agility tests (Gorostiaga et al., 2005), therefore knowledge about differences in general and team-handball specific performance in players of different performance level is lacking. Consequently, the aim of the study was to compare general and game based performance in elite, high and experienced team-handball players. Methods 36 (12 elite, 12 high experienced and 12 experienced) team-handball players performed a game based performance test (Wagner et al., 2014), an incremental treadmill-running test, a 30m sprinting test, lower and upper body strength test, and a counter movement jump (CMJ) test. We measured peak oxygen uptake (VO<sub>2</sub>peak), utilizing portable metabolic system (Cosmed K4B2), blood lactate concentration (BLCPeak) (EKF, Biosen C), heart rate (Polar, Kempele, Finland), sprinting time, and offensive and defensive time actions (Inmotion LPM-system, Abatec, Austria), ball velocity and jump height during a jump throw (PeakMotus, Vicon Peak, UK), isometric leg force and shoulder and trunk rotation torque (ISOMED, D&R Ferstl, Germany), as well as jump height in the CMJ (AMTI, Watertown, USA). One-way ANOVA was utilized to analyze differences in performance between elite, high and experienced team-handball players. Results We found significant differences ( $P < .05$ ) between elite, high and experienced players in VO<sub>2</sub>peak, defensive time and fast break time in the game based performance test, VO<sub>2</sub>max in the incremental treadmill running test, isometric leg force, shoulder and trunk rotation torque as well as body mass. Elite players performed best in isometric leg force (2400N), shoulder (90Nm), trunk rotation (250Nm) torque and body mass (93kg). Surprisingly, we found no significant differences in ball velocity, jump height and general sprinting time. Discussion In conclusion, we found that general and specific endurance, strength and power as well as specific agility and sprinting performance is essential to increase the level of performance in team-handball. However, elite team-handball players need a very high level of upper and lower body strength and power to tolerate hard physical contact (tackles in offence).

and defense) in team-handball competition. References Wagner H, Orwat, M, Pfusterschmied J, Hinz M, Bacharach D, von Duvillard SP, Müller E. (2014). *J Strength Cond Res*, (in press) Gorostiaga EM, Granados C, Ibanez J, Izquierdo M. (2005). *Int J Sports Med*, 3, 225-232.

### CHANGES IN PERCEIVED STRESS AND RECOVERY RELATE TO CHANGES IN SUBMAXIMAL PERFORMANCE IN TEAM SPORT PLAYERS.

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**Introduction** In team sport, it is known that players perceive more stress and less recovery during the competition phase compared to pre-season (di Fronso et al., 2013). It is assumed that these changes in perception of stress and recovery have an effect on athletic performance. Unfortunately, studies relating perceived stress and recovery to performance in team sport players are limited. Therefore the aim of this study is to investigate whether changes in perceived stress and recovery are related to field-test performance. **Methods** During one full season 47 male and female players (age:21.7±3.5yr, length:186.9±11.5cm, weight:82.5±14.9kg) reported perceived stress and recovery every 3 weeks by filling out the Recovery Stress Questionnaire for Athletes (RESTQ-Sport) (Nederhof et al., 2008). Furthermore, the Heart Rate Interval Monitoring System (HIMS) test was used to determine (submaximal) performance (Lamberts et al., 2004). The heart rate at the end of the test as a percentage of the maximal HR (%HRsubmax) was used as performance indicator with lower values indicating better performance. Between each consecutive RESTQ-Sport and HIMS test differences scores were calculated for perceived stress and recovery and %HRsubmax, respectively. Pearson correlations were used to determine the relation between changes in perceived stress and recovery and changes in HIMS performance. **Results** An increase in perceived General and Sport Stress correlated with an increase in %HRsubmax, ( $r=0.27$  and  $0.21$  respectively,  $p < 0.05$ ). An increase in perceived General and Sport Recovery correlated with a decrease in %HRsubmax ( $r=-0.24$  and  $-0.16$  respectively,  $p < 0.05$ ). **Discussion** Results show that increased perceived stress resulted in a performance decrease while an increase in perceived recovery results in a performance increase. To the best of our knowledge this is the first study relating perceived stress and recovery to submaximal HR in team sport players. However in triathletes similar results were shown (Coutts et al., 2007). More research is needed to explore the relation between perceived stress and recovery and performance in team sport players to optimize training regimens. **References** Di Fronso S, Nakamura F, Bortoli L, Robazza C, Bertollo M (2013). *Int J Sports Phys Perf*, 8:618-622. Coutts A, Wallace L, Slattery K (2007). *Int J Sports Med*; 28: 125 – 134. Lamberts R, Lemmink K, Durandt J, Lambert M (2004). *J Strength Cond Res*, 18(3):641-5. Nederhof E, Brink M, Lemmink K (2008). *Int J Sport Psychol*, 39(4), 301-311 Contact h.t.d.van.der.does@pl.hanze.nl

### EFFECT OF A COMPETITIVE SEASON ON ANTHROPOMETRIC, AEROBIC AND BIOCHEMICAL PARAMETERS IN BRAZILIAN FUTSAL PLAYERS

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**Introduction** Competitive season is a stress time because the busy calendar with a lot games can reduce the training days and may affect the performance of the athlete. Therefore, the aim of study was to describe the effects of a competitive season period on anthropometric, aerobic capacity and biochemical parameter in Brazilian futsal players. **Methods** Eleven Brazilian professional futsal players were monitored during 6 weeks of the competitive season composed of 13 games being the three last eliminatory. Anthropometric parameters were determined by Dual-energy X-ray absorptiometry, aerobic capacity (AT) and maximum aerobic velocity (MAV) by lactate minimum test in the specific circuit to futsal and arterial blood was collected after 24h of rest. The assessments were performed in the beginning and final of the season. The weekly training load was assessed using rating of perceived exertion from (RPE) and calculation of the training impulse (Trimp). The t-student test and one-way ANOVA were performed to compare the results between the weeks. **Results** The mean volume and intensity (RPE) were 378.1±142.7min and 5.7±0.13a.u. respectively. Trimp average was reduced through the season with a big reduction in the last week compared of the others weeks (365.4±101.5a.u.; 280.3±61.1a.u.; 419.7±51.0a.u.; 258.5±37.5a.u.; 275.4±46.5a.u.; 79.5±16.6a.u.; respectively,  $P < 0.05$ ). For the anthropometric parameters only bone mineral content had an increased (0.9±1.0%,  $P < 0.05$ ). However, the AT (pre=7.41±0.3km.h<sup>-1</sup>; post=8.08±0.7km.h<sup>-1</sup>) and MAV (pre=8.6±0.9km.h<sup>-1</sup>; post=9.7±0.7km.h<sup>-1</sup>) had a significant increase (9.0% and 13.5% respectively). Lactate dehydrogenase (pre=409.7±349.8U.L<sup>-1</sup>; post=349.7±77.8U.L<sup>-1</sup>) and creatinine (pre=1.1±0.1U.L<sup>-1</sup>; post=1.0±0.2U.L<sup>-1</sup>) were significantly reduced. However, the creatine kinase (pre=394.7±106.5U.L<sup>-1</sup>; post=326.3±177.2U.L<sup>-1</sup>) kept high in relation of the basal levels. **Discussion** The competitive season could not change the anthropometric parameters (Soares-Caldeira et al., 2014). However, the AT and MAV were significantly increased. In addition, the manipulation of workload can change the biochemical parameters (Milanez et al., 2014), although the training load were reduced through the season, this was not efficient to reduce all metabolic stress markers, in special the creatine kinase. Thus, only the strategy of reduce the workload seems not be a good strategy to reduce the metabolic stress during the competitive season. **References** Soares-Caldeira et al., (2014). *J Strength Cond Res*. 2014 Oct;28(10):2815-26. Vinicius F. Milanez, et al., (2014). *J Sports Sci Med*. 2014 Jan 20;13(1):22-9. eCollection 2014. Contact Barbieri\_ef@hotmail.com

## Oral presentations

### OP-PM60 Health & Fitness: Age II

#### PHYSICAL FITNESS IS PREDICTIVE FOR A DECLINE IN DAILY FUNCTIONING IN OLDER ADULTS WITH INTELLECTUAL DISABILITIES

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**Introduction:** The life expectancy of people with intellectual disabilities (ID) is increasing. Daily functioning, the ability to perform basic and instrumental activities of daily living (IADL), determines one's level of independence and need for care, and is an important predictor of hospital admission and mortality in older adults of the general population. Physical fitness is an important aspect for daily functioning, and low physical fitness levels have been found in older adults with ID. The aim of this study was to assess the decline in daily functioning

in older adults with ID ( $\geq 50$  years) over a 3-year follow-up period, and assess the predictive value of physical fitness for a decline in daily functioning. Methods: At baseline, an extensive physical fitness assessment was performed. In addition, professional caregivers completed the Barthel index, the Lawton IADL scale, and a questionnaire regarding mobility, both at baseline and at follow-up 3 years later. Results: A significant decline in daily functioning was seen over the 3-year follow-up period: 54.8% declined in their ability to perform ADL, 44.3% in their ability to perform IADL, and 37.5% declined in their mobility. At follow-up, only 12.6% of the participants were completely independent in ADL, 1.3% in IADL, and 48.5% had no mobility limitations, versus 15.1%, 2.7%, and 62.0% being completely independent at baseline in ADL, IADL, and mobility, respectively. For a decline in ADL, significant predictors were manual dexterity, visual reaction time, balance, comfortable and fast gait speed, muscular endurance, and cardiorespiratory fitness. For a decline in IADL, manual dexterity, balance, comfortable and fast gait speed, muscular endurance, and cardiorespiratory fitness were significant predictors. For a decline in mobility, manual dexterity, balance, comfortable and fast walking speed, grip strength, muscular endurance, and cardiorespiratory fitness were all significant predictors. Discussion: These results show that physical fitness is predictive for a decline in daily functioning in older adults with ID. This study shows that even though older adults with ID already experience dependency on others due to cognitive limitations, physical fitness is an important predictor of daily functioning, which stresses the importance of using physical fitness tests and physical fitness enhancing programs in the care for older adults with ID. Contact Alyt Oppewal (a.oppewal@erasmusmc.nl)

### IS THERE A LINK BETWEEN ASYMMETRIES IN STRENGTH, GAIT AND BALANCE IN SENIORS?

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Introduction Balance, strength and gait asymmetries are independent risk factors for falls. It remains, however, unclear whether strength asymmetry affects balance and gait asymmetries in elderly people. Methods Leg strength and gait as well as balance were assessed in 48 healthy seniors ( $70 \pm 5$ y,  $1.68 \pm 0.09$ m,  $74 \pm 14$ kg). Unilateral leg press and plantar flexion were tested on an isokinetic dynamometer (IsoMed 2000, D&R Fersil, Hemau, Germany). Gait analysis was conducted on a one-dimensional ground reaction force measuring treadmill (FDM-T system, Zebris Medical GmbH, Isny, Germany). Single-limb stance with closed and open eyes (SLEC and SLEO) was tested on a force plate (Kistler, 9286BA, Winterthur, Switzerland). We calculated symmetry indices (SI) for strength, gait and balance variables and coefficients of variation (CV) for gait variables. Symmetric and asymmetric participants were defined by dichotomizing the whole group by median split for leg press and plantar flexion force and rate of force development (RFD), respectively. Then, between-group differences were calculated for gait and balance. The smallest worthwhile difference was considered as 0.2 of the between-subject standard deviation. Results Participants with asymmetric plantar flexion force and RFD showed likely (probability: 89% and 77%; standardized mean difference: 0.4 and 0.7) higher SLEC SI. Leg press force asymmetric participants showed likely (94%, -0.7) higher SLEO SI, however, the weaker balance was present at the stronger leg. There was also a likely (86%, 0.6) higher asymmetry in SLEO SI in participants with asymmetric leg press RFD. In terms of gait asymmetry, participants with asymmetric plantar flexion force had a likely (76%, -0.4) higher weight acceptance force SI going along with less weight on the strong leg and a likely (88%, 0.5) higher step length SI. Step length SI was very likely (95%, -0.6) higher in participants with asymmetric leg press force, with stronger side being shorter, and very likely (99%, 0.9) higher in participants with asymmetric leg press RFD. Step time SI was likely (79%, -0.5) higher in participants with asymmetric leg press RFD, with shorter steps with the stronger leg. Gait variability was likely or very likely (76 to 99%, 0.4 to 1.0) higher in stride width, cadence, stride length and double support time CVs in participants with asymmetric plantar flexion force and plantar flexion RFD. Discussion Especially plantar flexion force and RFD showed interesting associations with gait and balance asymmetries and variability. The development of more symmetric strength might be a strategy to influence gait and balance and possibly fall risk. However, this is yet to be determined in further intervention studies. Contact daniel.hammes@unibas.ch

### PHYSICAL ACTIVITY IN OLDER ADULTS: ITS ASSOCIATION WITH LOWER EXTREMITY JOINT RANGE OF MOTION AND MUSCLE FORCE

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Introduction Aging is commonly linked to a reduction in lower extremity joint range of motion (ROM) and physical function (James and Parker, 1989). The decreased health and function in older adults were related to less physical activity (Mor et al., 1989). Therefore, the aim of this study was to identify lower extremity ROM and muscle force that significantly contribute to physical activity in older adults. Methods Ninety-one older adults (16 men and 75 women; age,  $71.5 \pm 5.2$  years; height,  $1.54 \pm 7.0$  m; weight,  $54.0 \pm 6.9$ kg) were recruited for this study. Pain, smoking, alcohol consumption, and comorbidity were obtained by self-report. Active ROM for 9 lower extremity motions and 2 lower extremity muscle forces were measured. The Japanese version of Physical Activity Scale for the Elderly (JPASE) was used to examine physical activity in older adults. JPASE was divided into two components; leisure activity component and housework and job activity component. To quantify the influence of participant demographics, physical characteristics, active ROM and muscle force on JPASE, hierarchical stepwise models were constructed using leisure activity and housework and job activity as the dependent variable. The first model (model 1) contained all lower extremity ROM, the second model (model 2) participant demographic and physical characteristic variables were added, and the third model (model 3) included all variables. Results In model 1, hip extension ROM was the independent variable to emerge as a predictor of leisure activity. In model 2, pain was a significant predictor of leisure activity, and a loss in the significant influence of hip extension ROM on leisure activity. In model 3, only hip flexion muscle force was a predictive factor of leisure activity. However, all variables were not found to be significant independent predictors in housework and job activity. Discussion The findings of this study indicate that mild or no pain, wide hip extension ROM and strong knee flexion muscle force were important factors for maintenance of vigorous physical activity in older adults. However, hip extension ROM and knee flexion muscle force may not be related to housework and job activity, because all lower extremity ROM and muscle force were not correlated to housework and job activity. References Mor V, Murphy J, Masterson-Allen S, et al. Risk of functional decline among well elders. *J Clin Epidemiol* 42:895-904, 1989. James B, Parker AW. Active and passive mobility of lower limb joints in elderly men and women. *Am J Phys Med Rehabil* 68:162-167,1989.

**SMART: IS PAIN A RELEVANT BASELINE CHARACTERISTIC IN THE ELDERLY? RESULTS FROM A RCT**

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Background: Physical activity exerts a variety of long-term health benefits in older adults. In particular it is assumed to be a protective factor against cognitive decline and dementia. However, several side factors such as pain have been correlated to the topic of cognition, thus possibly influencing these trials. Methods/Design: Randomised controlled assessor blinded two-armed trial (n = 60) to explore the exercise induced neuroprotective and metabolic effects on the brain in cognitively healthy older adults. Participants (age > 65), recruited within the setting of assisted living facilities and newspaper advertisements were allocated to a 12 week individualised aerobic exercise program intervention or a 12 week waiting control group. The main outcome is the change in cerebral metabolism. Secondary outcomes include a broad range of psychometric (cognition) and movement-related parameters such as nutrition, history of physical activity, history of pain and functional diagnostics. The randomisation sequence is compiled by a computer program. For allocation exercise physiologists open opaque envelopes assigning groups of 5 participants to the respective group, with assessors and study personal other than exercise physiologists being blinded. The trial registration is NCT02343029 (clinicaltrials.gov). Results: At this conference we will present for the first time the baseline characteristics and the impact of pain on a group of 60 participants (mean age: 75.5 years / 33 female) enrolled in the above described SMART-study. Moreover, the exercise program as well as MRSI methods and psychometric tests used in this study will be introduced. Discussion: Strength of the present protocol is to control for a large subset of possibly influencing factors, in particular the influence of the history and incidence of pain. This comprehensive understanding allows to identify or control for confounders predicting improved or reduced benefit from physical exercise in the elderly.

**EFFECT OF MILK VS LEUCINE FORTIFIED MILK SUPPLEMENTATION ON BODY COMPOSITION AND STRENGTH IN OLDER ADULTS UNDERGOING 12 WEEKS OF RESISTANCE TRAINING.**

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Introduction Protein supplementation (PS) and resistance training (RT) has been proposed as effective strategies to enhance muscle mass and strength. However, less evidence suggested that the consumption of milk or leucine fortified milk may enhance muscle protein synthesis and attenuate protein breakdown. The aim of our study was to compare the effect of milk and fortified milk supplementation combined with or without 12-week of RT on body composition and strength in elderly. Methods One hundred and forty two healthy untrained men and women aged 55-75 yr, were randomly assigned to 1 of 6 groups: milk group + exercise TS (MTS), fortified leucine-milk group +exercise (LMTS), milk group + exercise HRC (MHRC), fortified leucine-milk group +exercise HRC (LHRC), milk group (MG) and fortified milk group (LMG). Exercise groups performed 2 days-per-week of periodized resistance training program for 12 weeks. All groups consumed 500 ml/day. Timing of ingestion was protocolised (250ml/morning and 250ml/night). Fat free mass (FFM) and fat mass (FM) were assessed on a whole-body Dual-energy X-ray absorptiometry (DXA). Strength was assessed by isokinetic dynamometry in the upper and lower body. Results After 12 weeks, there were significant improvements in FFM and FM ( $p < 0.05$ ). Only MG have no significant changes in FFM and a significant increase in FM. There were statistical differences between groups in FFM and FM ( $p < 0.05$ ). There were significant increases in isokinetic strength in all groups ( $p < 0.05$ ). Discussion Our main finding is that daily supplementation with 500ml of fortified leucine milk only, further augment SPM in elderly population. The present data are consistent with another results that have showed that low-intensity activities of daily living, such as walking, improve MPS and insulin-sensitivity in the elderly (Fujita S, et al., 2007). Another findings of the current study showed that FFM and strength increased in the RT groups, however FM decreased in all groups less MG. Our findings support the speculations that RT and/or consumption of leucine-fortified-proteins could cause a decreased MSB and lower protein requirements for maximal stimulation of MPS (Moore DR, et al., 2015). References 1. Fujita S, et al. Diabetes. Junio de 2007;56(6):1615-22. 2. Moore DR, et al. J Gerontol A Biol Sci Med Sci. 1 de enero de 2015;70(1):57-62. Contact fsoto@ucam.edu

**Oral presentations****OP-PM57 Health & Fitness: Children I****THE IMPACT OF CYCLING DESKS ON IN-CLASS ENERGY EXPENDITURE.**

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Introduction Sedentary behaviour has negative effects on several physical and cognitive health parameters. However, at school, pupils spend the majority of their days in sedentary behaviours. In this study, we aimed to investigate whether providing cycling desks in classrooms, can have an effect on pupils' in-class energy expenditure (EE) and to quantify this effect. Methods Participants were recruited in the 3th and 4th grade of a Belgian high school and were randomly assigned to control (CG) (12 girls, 13 boys) and intervention (IG) (13 girls, 9 boys) group. Anthropometric parameters, performance on the 20m shuttle run test and pubertal status were measured at baseline. The pupils of the IG were provided with a cycling desk for 4 class hours of 50 minutes per week. All participants wore a Sensewear armband on the right upper arm for 6 consecutive days (4 school days, 2 weekend days). An independent samples t-test was used to determine if EE was different between CG and IG, during normal class hours. Subsequently, a repeated measures anova mixed design was performed to check if a possible difference in EE depended on the group to which the pupils were assigned. In case of a significant interaction-effect, a repeated measures anova was performed within the IG and the CG. Results Average age ( $14.4 \pm 0.6$  y;  $14.2 \pm 0.6$  y), height ( $1.68 \pm 0.07$  m;  $1.68 \pm 0.07$  m), body weight ( $56.1 \pm 9.3$  kg;  $55.2 \pm 10.9$  kg), BMI ( $19.8 \pm 3.4$ ;  $19.6 \pm 3.5$ ), fat percentage ( $18.1 \pm 10.0\%$ ;  $18.7 \pm 8.9\%$ ), waist circumference ( $66.6 \pm 5.1$  cm;  $66.3 \pm 7.2$  cm), level 20m shuttle run test ( $6.2 \pm 2.4$ ;  $6.6 \pm 2.6$ ) and pubertal status ( $2.8 \pm 0.4$ ;  $2.7 \pm 0.4$ ) were not significantly different ( $p > 0.05$ ) between CG and IG. EE was not significantly different between CG and IG during normal class hours ( $p > 0.05$ ;  $95.6 \pm 12.5$  kcal/h vs.  $94.4 \pm 17.8$  kcal/h). However, the difference in EE in the different classroom settings, was depending on the assigned condition ( $p < 0.001$ ). Mean EE of the IG was significantly higher during the class hours in which they had access to the cycling desks than during the normal class hours ( $p < 0.001$ ;  $126.1 \pm 35.3$  kcal/h vs.  $94.4 \pm 17.8$  kcal/h), while this was not significantly different for the participants of the CG ( $p > 0.05$ ;  $95.3 \pm 14.9$  kcal/h vs.  $95.6 \pm 12.5$  kcal/h). Discussion and conclusion In this



study we found a 32% increase of EE during class when bike desks were available. This shows that providing bike desks in classrooms can be effective to increase in-class EE. However, the experience of the pupils using these desks as well as the effect of cycling during class on attention and academic performance needs further investigation. Contact Tine.Torbeyns@vub.ac.be

### IMPACT OF LIVING AREA ON ANTHROPOMETRIC AND PHYSICAL FITNESS PARAMETERS AMONG 15-YEAR-OLD ADOLESCENTS IN KOSOVO

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**Introduction** Overweight and obesity have been increasing systematically over the past decades and physical fitness values on the other hand have been decreasing (1). However, in low- and middle-income countries we observe the co-occurrence of over- and under-nutrition at the same time – a phenomenon that has been termed the ‘dual burden’ (2). In addition, it is discussed whether the urban-rural environment is a facilitating factor for developing obesity and low physical fitness levels (3,4). The aim of the current study was to test for the impact of the living area on body composition and physical fitness parameters among 15-year-old adolescents in Kosovo. **Methods** Three-hundred fifty-four subjects (55% boys, 46% girls; mean age: 14.6 ± 0.4) participated in the current cross-sectional study conducted in 2014. Out of the total sample, 39% of the participants were living in a rural environment and 61% in an urban area (Pristina) in Kosovo. Anthropometric parameters including skinfold measurement and physical fitness levels (handgrip strength, sit and reach, standing long jump, countermovement jump, medicine ball throw, 10-m, 20-m sprints and multistage fitness test) were tested. A two-factorial ANOVA (sex, area of living) was used to test for differences between groups. **Results** The prevalence for underweight was 13.8%, normal weight 61.9% and 24.3% for overweight adolescents respectively. Living area had no impact on anthropometric variables ( $p > 0.05$ ). Differences in physical fitness tests were observed only in medicine ball throw ( $p < 0.001$ ) with urban living adolescents performing better, whilst contrary 10-m ( $p = 0.012$ ), and 20-m ( $p = 0.035$ ) sprint test were executed faster by rural counterparts. **Discussion** Similar to another study in low-income countries (5) we observed a high incidence of both, under- and overweight in Kosovar adolescents while rural or urban environment had no influence on anthropometric variables and only a modest and controversial impact on physical fitness. The reasons for these findings remain speculative and may rely on socioeconomic conditions, access to sports facilities, and differences in general lifestyle behavior (6). **References** (1) Ng M et al., *Lancet*. 2014;384(9945):766-81 (2) Popkin BM & Slining MM. *Obes Rev*. 2013; 14 Suppl 2:11-20 (3) Albarwani S et al., *Metab Syndr Relat Disord*. 2009;7(4):369-74 (4) Lutfyyia MN et al., *Obesity* (Silver Spring). 2007; 15(9):2348-56 (5) Jaacks LM et al., *Pediatr Obes*. 2015 Jan 5. doi: 10.1111/ijpo.12000 (6) Davison KK & Lawson CT. *Int J Behav Nutr Phys Act*. 2006 Jul 27;3:19 Contact faton.tishukaj@uni-pr.edu

### LOCALIZATION OF PHYSICAL ACTIVITY IN PRIMARY SCHOOL CHILDREN USING ACCELEROMETER AND GLOBAL POSITIONING SYSTEM

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**Introduction** Ecological approaches highlight the importance of the built environment as factor which can influence physical activity (PA) (1). However, data on children’s activity patterns are still incomplete. Particularly, little is known about where PA takes place. Therefore, assessing in which context PA occurs would be a first fundamental step to design future location-based interventions to promote PA. Using the new combination of global positioning system (GPS) and accelerometer, the study aimed to identify locations where children spend time and engage in moderate-vigorous physical activity (MVPA). **Methods** In spring 2013, 119 Swiss children (age=12.5±0.4) participated in the study. During waking hours of a regular school week, participants wore an accelerometer and a GPS sensor for seven consecutive days. Accelerometer and GPS data were matched by time and mapped with a geographical information system. Seven location categories which relate to active living were defined. For each location, total time spent was assessed and the amount and percentage of MVPA was calculated. Multilevel analyses were conducted for three outcome measures accounting for the hierarchical structure of the data (2). Furthermore, contrasts were used to investigate any gender differences. **Results** Children spent 37.5% of the time at home, 26.7% at own school, 0.7% at other schools and 14.2% on streets. Only about 20 minutes (0.7%) were recorded in recreational facilities such as parks or sports fields. The only gender difference was found at other schools where boys spent significantly more time than girls. In general, children recorded 8.4% of the time as MVPA. Boys were more active than girls, spending an average of 348.5 minutes vs. 284.6 minutes per week in MVPA. Girls achieved most of their MVPA on streets (38.0%), whereas boys were most active at own school (28.7%). Both, at own and other schools, boys achieved significantly more minutes in MVPA than girls. Taking into account the total time spent in a location, the percentage children engaged in MVPA was highest in recreational facilities (19.4%), other schools (19.2%) and streets (18.6%). The percentage spent as MVPA at own school was only 8.6%. However, the proportion at home was even smaller (3.0%). **Discussion** The results indicate that streets and school grounds are important locations where children can achieve their recommended PA level. However, it seems that the school environment is more likely to encourage boys than girls to be physically active. The high use of streets may be an indicator for active transportation which can be an important contributor to an active lifestyle. **References** (1) Bauman AE et al. (2012). *Lancet*, 380, 258-271. (2) Cerin E (2011). *J Plan Lit*, 26(2), 151-167. Contact rahel.buerigi@hest.ethz.ch

### LONGITUDINAL CHANGE IN PHYSICAL ACTIVITY OF CHILDREN IN HUNAN, CHINA

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**Introduction** An important strategy in order to achieve healthier body composition is to encourage a lifetime physical activity participation in overweight/obese children (WHO, 2004). Therefore, assessing physical activity (PA) is especially important because increasing PA in childhood might be essential to develop a physically active lifestyle. However, most previous investigations have been cross-sectional studies on Chinese children. No longitudinal studies that address this issue among children have been reported and whether these same causes are related to PA in Chinese children is uncertain. In this study we examined the association between longitudinal change and weight status in schoolchildren’s PA. **Methods** Baseline measures were collected in 2011, when the children were aged 7~8 years, and follow-up data were collected in 2014, when the children were aged 10~11 years. The children (n=77) consisted of normal-weight children (NW), overweight/obese children (OW/OB) who determined by BMI according to Working Group for Obesity in China cut offs over two time point between 2011 and 2014. We describe change in daily step counts and moderate to vigorous physical activity ( $\geq 3$  METs, MVPA) was studied using one axis accelerometer in children. **Results** Between 2011 and 2014, the daily time spent in MVPA were de-

clined from  $67.4 \pm 21.7$  min to  $64.1 \pm 30.8$  min for boys and  $54.5 \pm 14.2$  min to  $45.5 \pm 19.6$  min for girls. The girls were significantly higher rate of change (RC) of MVPA than boys (-13.5% versus -0.1%,  $p < 0.05$ ). In the boys group, the daily time spent in MVPA of NW were increased from  $71.2 \pm 23.5$  min to  $73.9 \pm 29.4$  min, while OW/OB were declined from  $62.1 \pm 18.0$  min to  $50.5 \pm 27.6$  min. In the girls groups, MVPA were declined from  $54.5 \pm 14.2$  min to  $49.4 \pm 17.8$  min for NW and  $54.5 \pm 14.4$  min to  $39.1 \pm 21.0$  min for OW/OB. Hence, in both boys and girls group, OW/OB children were also significant higher RC of MVPA than NW children (-15.8% versus +10.1% for boys; -28.2% versus -4.4% for girls,  $p < 0.05$ ). Discussion The present study was the first study to report on the longitudinal investigation between PA and overweight/obesity in the Chinese children. There were decreases in MVPA by weight statue in both boys and girls, supporting previous studies that reported age-related declines in PA1) and the notion that declines in daily physical activity starts at a young age2), especially OW/OB children. Hence, OW/OB children had lower MVPA through our study and the extent of RC did differ from NW children, suggesting that OW/OB children should also be a priority for PA promotion. Reference 1. Hardy, L. L., et al J adolesc Health 2007; 40: 158-65 2. Nelson, M.C., et al Pediatrics 2006; 118: e1627-34 Contact houu.tou@gmail.com

### SMARTPHONE APPS TO IMPROVE CARDIORESPIRATORY FITNESS AND INCREASE PHYSICAL ACTIVITY LEVELS AMONG YOUNG PEOPLE: THE AIMFIT RANDOMISED CONTROLLED TRIAL

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Introduction: Worldwide, 80.3% of adolescents aged 13-15 years do not reach current physical activity (PA) recommendations and are at risk of preventable non-communicable diseases (Hallal et al., 2012). There is an age-related decline in PA in young people, which tracks into adulthood (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008). Common technologies, such as smartphones and apps, may enhance the appeal of interventions to increase levels of PA among this population. The AIMFIT trial investigated the effects of a mHealth delivered PA intervention to improve fitness compared with usual behaviour in young people not meeting the PA recommendations. Methods: A three-arm, parallel, randomised controlled trial was conducted in 2013-14 in Auckland, New Zealand. Fifty-one eligible participants aged 14-17 years were randomised to one of three conditions: 1) use of an immersive smartphone app ( $n=17$ ), 2) non-immersive app ( $n=16$ ), or 3) usual behaviour (control  $n=18$ ). The apps consisted of an eight-week training program designed to improve fitness and ability to run 5 km. Data were collected at baseline and 8 weeks. The primary outcome was cardiorespiratory fitness, assessed as time to complete the one mile run/walk test at 8 weeks. Secondary outcomes were PA levels (PAQ-A and accelerometry), self-efficacy (PASES), enjoyment (PACES), psychological need satisfaction (PNSES) and acceptability and usability of the apps. Results: Participants were on average 15.7 years old (14-17 years), mostly NZ Europeans (61%) or Pacific Islanders (22%) and females (57%). Preliminary findings indicate group assignment did not have a significant effect on fitness. Compared to the control, mean ( $\pm$ SE) baseline fitness test-, sex-, and multiple comparisons-adjusted fitness test changes were  $-28.4 \pm 15.4$  and  $-24.7 \pm 15.7$  seconds for the immersive and non-immersive app groups, respectively. Most participants used the app 2 times/week (32%), 25% only used it 1 time/week and 9% none. 81% were interested in trying different apps in the future. Discussion: While our pragmatic approach using commercially available apps as a stand-alone instrument to improve fitness did not show significant effects, interest in future use of PA apps is promising and suggests a potential role of such instruments in a multifaceted approach to promote PA. References: Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., & Ekelund, U. (2012). Global physical activity levels: surveillance progress, pitfalls, and prospects. *The Lancet*, 380(9838), 247-257. Nader, P. R., Bradley, R. H., Houts, R. M., McRitchie, S. L., & O'Brien, M. (2008). Moderate-to-vigorous physical activity from ages 9 to 15 years. *JAMA*, 300(3), 295-305. Contact: a.direito@auckland.ac.nz

### PHYSICAL ACTIVITY AND INTRA-ABDOMINAL FAT IN YOUNG ADULTHOOD: A CO-TWIN CONTROL STUDY

Rottensteiner, M.1, Leskinen, T.2, Järvelä, E.3, Väisänen, K.4, Aaltonen, S.5, Kaprio, J.5, Kujala, U.M.1

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1: JYU (Jyväskylä, Finland), 2: UTU (Turku Finland), 3: UEF (Kuopio, Finland), 4: JAMK University of Applied Sciences (Jyväskylä, Finland), 5: University of Helsinki (Helsinki, Finland) Introduction Considering the recognized health consequences of intra-abdominal fat and growing trends of abdominal obesity, understanding the role of physical activity in preventing intra-abdominal fat accumulation already among younger adults is of great importance. We aimed to investigate the differences in abdominal fat compartments between young adult monozygotic (MZ) twin pairs discordant for leisure-time physical activity. MZ twins are matched on genetic makeup and multiple childhood experiences, allowing for better control of known and unknown confounders. Methods Ten young adult male MZ twin pairs (age range 32-36 y) discordant for leisure-time physical activity during the past 3 years (mean difference 3.3 MET-h/d) were systematically selected from a population-based Finnish twin cohort. Physical activity discordance of MZ twin-pair was determined by physical activity questionnaires and interviews. MRI of abdomen was conducted to define intra-abdominal (both intraperitoneal and retroperitoneal fat) and subcutaneous fat masses. Prediction of fat masses was based on single MRI slice at the level of lumbar (L2-L3 intervertebral disc (Abate et al 1997). Dietary intake was assessed with a 4 d food diary. Differences in abdominal fat compartments and dietary intake between co-twins were analyzed with pairwise tests. Results Inactive twins had 31% more intra-abdominal fat than their active co-twins (mean difference 0.52 kg, 95% CI 0.12 to 0.91,  $P=0.016$ ), whereas the difference in subcutaneous abdominal fat was only 13% ( $P=0.21$ ). Intraperitoneal fat mass was 41% higher among inactive compared to active co-twins (mean difference 0.41 kg, 95% CI 0.11 to 0.70,  $P=0.012$ ). In retroperitoneal fat the intrapair difference was 16% ( $P=0.10$ ). Dietary intake did not differ between co-twins. In individual based correlations intra-abdominal fat was strongly associated with the markers of glucose homeostasis, i.e. fasting glucose ( $r=0.675$ ,  $P=0.001$ ), fasting insulin ( $r=0.516$ ,  $P=0.02$ ) and HOMAindex ( $r=0.579$ ,  $P=0.008$ ). Conclusions A lower level of physical activity is related to larger amount of intra-abdominal fat already among healthy adult males in their mid-30s. The findings highlight the importance of leisure-time physical activity, independent of diet and genes, in the prevention of intra-abdominal fat accumulation already from early adulthood onward, and hence in avoiding possible development of related metabolic complications. Reference Abate N, Garg A, Coleman R, Grundy SM, Peshock RM. (1997). *Am J Clin Nutr*, 65, 403-408 Contact mirva.rottensteiner@ju.fi

## Oral presentations

### OP-SH08 Psychology (Challenges within Sport Psychology I)

#### LINKS BETWEEN ADOLESCENTS' INVOLVEMENT IN SPORT, ATTACHMENT TO PARENTS AND PROSOCIAL BEHAVIOUR

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**Introduction** Adolescents' attachment to key caregivers is of the highest importance and likely to reflect the nature of internal working models in youth sports that may well function as a psychological template during the construction of youth prosocial behavior (Carr 2009). The aim of this study was to examine links between adolescents' involvement in sport, attachment to parents and prosocial behaviour. **Methods** The sample included 1348 adolescents, aged 12–16 (716 girls and 632 boys, M age=14.20 years, SD=1.52). 39.2% of the research participants (n=529) were involved in sports for at least two years. Prosocial Tendencies Measure – Revised (Carlo, Hausmann, Christiansen et al., 2003) was used in this study to measure adolescents' prosocial behaviour. Adolescents attachment to their parents was measured by modified Inventory of Parent and Peer Attachment – Revised (Gullone & Robinson, 2005). Hierarchical regression analyses were applied to examine the effects of participation in sport and attachment to parents on prosocial behaviour. **Results** Regression analyses revealed that involvement in sport was significantly positively associated with total attachment to parent ( $\beta=.08$ ,  $p<.01$ ) and prosocial behaviour ( $\beta=.06$ ,  $p<.05$ ). Total attachment to parents was significantly associated with adolescents prosocial behaviour ( $\beta=.14$ ,  $p<.001$ ). The overall model entering involvement in sport and attachment to parent explained 15% of the variance in prosocial behaviour, and was statistically significant ( $F(2,1347)=16.56$ ,  $p<.001$ ). **Discussion** Adolescents' participation in sport plays a considerable role in relation to parent-child attachment and prosocial behavior in adolescents. Our research has found that children securely attached to their parents and actively involved in sport will be protected from delinquent behaviour and will behave in a more prosocial manner. Our research supports Holt, Knight (2014) statements that children's involvement in sport changes parents' behaviour and interest in sport activities, encourages positive emotions and improves relationships between children and parents. Early parent-child relations are a critical factor for interpersonal relationships in youth sports and have an influence on further relations and formation of behaviour (Carr, 2014). **References** Carlo, G., Hausmann, A., Christiansen, S., Randall, A. (2003). *Early Adolescence*, 23, 107-134. Carr, S. (2009). *Psychology of Sport and Exercise*, 10, 653-61. Gullone, E., Robinson, M. (2005). *Clin. Psychol. Psychother*, 12, 67-79. Holt, N.L., Knight, C.J. (2014). *Parenting in Youth Sports*, 49-50. London and New York: Routledge. Contact: lisinskiene@gmail.com

#### NEUROPSYCHIATRIC DISORDERS FOLLOWING PEDIATRIC SPORTS-RELATED CONCUSSION

Ellis, M.J., Ritchie, L., Cordingley, D., Chu, S., Selci, E., Leiter, J., Russell, K.

*University of Manitoba*

**Introduction:** Psychiatric outcomes following sport-related concussion (SRC) in youth are not well understood but their clinical management can be difficult and require a multi-disciplinary approach including behavioral and pharmacological treatment options. The objective was to describe the psychiatric diagnoses, treatments, and outcomes of youth who presented with a SRC. **Methods:** A retrospective chart review was completed on all youth aged 13-18 years of age who presented to the Pan Am Concussion Program in Winnipeg, Canada and who met the Zurich Consensus Statement definition of a SRC. Baseline characteristics included age, sex, sport, previous concussions, initial Post Concussion Symptom Scale score, family history of psychiatric disorders, and previous psychiatric disorders that met the Diagnostic and Statistics Manual of Mental Disorders IV criteria. Psychiatric outcomes of interest included the diagnosis of novel psychiatric disorders or the worsening of a pre-SRC psychiatric disorder. Novel psychiatric disorder was defined as a newly diagnosed psychiatric disorder that occurred in the youth with or without a different lifetime pre-injury psychiatric disorder following a concussion. Characteristics of those with and without psychiatric outcomes were compared using the Chi-square test. **Results:** The study included 174 youth, 61.5% were male, the mean age was 14.2 years (SD 2.3), 13.3% had a pre-SRC psychiatric disorder, and the most common sports were hockey (35.6%) and soccer (18.4%). Overall, 20 (11.5%) youth experienced a psychiatric outcome: 16 were diagnosed with a novel psychiatric disorder and four experienced a worsening of pre-SRC psychiatric disorder. Eleven youth were diagnosed with novel depression-related disorder and five with novel anxiety-related disorders. Youth who met the criteria for a post-SRC psychiatric diagnosis were significantly more likely to have a pre-morbid psychiatric disorder ( $p<.001$ ) or a family history of psychiatric disorders ( $p=0.002$ ). They were significantly more likely to report sadness ( $p=0.001$ ), nervousness ( $p=0.001$ ), and being more emotional ( $p=0.008$ ) at their first medical appointment than those with no psychiatric outcome. There was no difference in irritability ( $p=0.089$ ). Fifteen youth were referred to a psychiatrist. Seven youth reported suicidal ideation and three attempted suicide, one of which was successful. Three youth were prescribed medication alone, three received cognitive behavioral therapy, and nine received a combination of treatments. Nine youth remain in treatment. **Discussion:** Increased frequency of post-SRC psychological difficulties was associated with pre-morbid or family history of psychiatric disorder. Subjective report of emotional symptoms on intake was associated with a higher rate of psychiatric disorders following SRC. Successful management of the neuropsychiatric manifestations of SRC requires prompt recognition and a multi-disciplinary approach utilizing trained medical experts in pediatric concussion and psychiatry.

#### SPECIFICS AND CHALLENGES IN FEMALE ATHLETES' CAREER DEVELOPMENT

Tekavc, J., Wylleman, P., Cecic Erpic, S.

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**Introduction** Developmental lifespan model (Wylleman, Reints, & De Knop) identifies several stages (i.e., initiation stage, development stage, mastery stage, discontinuation stage) through which the athletes progress in their athletic career development. Since the model provides a gender non-specific description of athletes' career development, the aim of this study was to investigate into female athletes' athletic career and identify possible specifics and challenges they face in comparison with male athletes. **Methods** Semi-structured interviews with 90 talented and elite Slovene athletes (n = 45 males, 45 females) were used for the purposes of this study. Participants came from various types of sport and equally represented three stages of athletic career development: development stage (n = 30), mastery stage (n = 30), and discontinuation stage (n = 30). The interview guide was based on the Holistic Athletic Career model (Wylleman et al., 2013). The interviews lasted between 45 and 75 minutes. They were transcribed verbatim and content analyzed using the qualitative analytic software program (QSR NVivo 10). **Results** Both, male and female athletes experienced several transitions and

challenges in different stages of their athletic career. In comparison to male athletes, female athletes reported some specific characteristics and difficulties connected to different levels in their athletic career: (1) at the athletic level, they more often reported missing additional professional support and ended their athletic career earlier than male athletes; (2) at the psychological level, they more often mentioned dealing with low levels of self-confidence and weight issues; (3) at the psychosocial level, female athletes more often complained about their coach not being supportive enough or reported about coach's negative behaviour; (4) at the academic/vocational level, female athletes showed a high determination to finish their education and more often than male athletes decided to continue their education on a higher education level. Discussion The findings of this study support the general framework of athletes' development as proposed by the Holistic athletic career model (Wylleman et al., 2013) and give some additional findings about female athletes' development in particular. They suggest that female athletes face some specific demands and challenges in their athletic career development, which calls for additional research in this field. References Wylleman, P., Reints, A., & De Knop, P. (2013). A developmental and holistic perspective on the athletic career. In L. Wei (Ed.), Abstracts of the ISSP 13th World Congress of Sport Psychology. (p. 2). Beijing: ISSP - Beijing Sport University.

## PARADOXICAL FUNCTIONS OF EXERCISE IN WOMEN WITH ANOREXIA NERVOSA

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Introduction Despite the substantial role of compulsive exercising (CE) in the development, aetiology and maintenance of anorexia nervosa (AN) (Davis et al., 1997) and the emphasis on CE as a major emotion regulation strategy in AN (Boyd et al., 2007, Lawson et al., 2007), the nature of this relationship and the experiential meaning of exercising for individuals with AN has received little attention. The aim of this study is to build a portrayal of subjective experiences of CE in individuals with AN. Method A qualitative interview was conducted with six female participants who have AN and who were compulsive exercisers. Four participants were former athletes. IPA was used to explore and situate the means whereby participants make sense of their experiences (Smith et al., 2009). Results This paper reports on the first superordinate theme that conceptualizes the participants' experiences of CE, paradoxical functions of exercise. First, an account of the participants' feelings about their engagement with CE as an experience of emotion escape and regulation is presented. Second, the participants' experience of embodied emotional states and how exercise is used to ease the body are explored. Third, the meaning of exercise in relation to the participants' sense of self and identity is examined. Discussion The obligation to exercise seems to be essentially connected with avoidance of participating in emotional and relational talk and potential conflicts. Contrary to previous observations of impaired emotion recognition in the self, participants in this study vividly described sensing of feelings as bodily sensations suggesting that they recognize emotions in the self and grasp what goes on within and around themselves through their bodies. Embodied feelings seem to offer some sense of connecting with their emotions. The substantial role of self-expression and belonging through compulsive exercising was particularly obvious in the accounts of the four women who were former athletes. For them, being good at sports and exercising was fundamental in determining a sense of self. This study shows that the multi-layered and meaningful endeavour of exercising in individuals with AN, makes it extremely difficult to reduce or end the exercising. References Boyd, C., Abraham, S. & Luscombe, G., 2007. Exercise behaviours and feelings in eating disorder and non-eating disorder groups. *European Eating Disorders Review*, 15, 112-118. Davis, C., Katzman, D.K., Kaptein, S., Kirsh, C., Brewer, H., Kalmbach, K., Olmsted, M.P., Woodside, D.B. & Kaplan, A.S., 1997. The prevalence of high-level exercise in the eating disorders: Etiological implications. *Comprehensive Psychiatry*, 38, 321-326. Lawson, R., Waller, G. & Lockwood, R., 2007. Cognitive content and process in eating-disordered patients with obsessive-compulsive features. *Eating Behaviors*, 8, 305-10. Smith, J.A., Larkin, M. & Flowers, P., 2009. *Interpretative phenomenological analysis: theory, method and research* Los Angeles: SAGE.

## THE RELATIONSHIP BETWEEN STUNKARD IMAGES, PERCEPTION OF BMI AND PERCEPTION OF SELF-CONCEPT IN SPANISH ADOLESCENTS

Sánchez-Miguel, P.A., Pulido, J.J., Chamorro, J.L., Sánchez-Oliva, D., Aamado, D., González-Ponce, I., Leo, F.M., García-Calvo, T.

*University of Extremadura*

Introduction The aim of this study was to examine the relationships between a subjective assessment Body Mass Index (BMI), a perception of the body image with Stunkard figure Rating Scale, as well as perception of self-concept in youth scholars from Extremadura (Spain). Methods The sample was formed by 2061 youth scholars from Extremadura (Spain), both males (N = 1038) and female (N = 1023), ranging in age from 15 to 17 years old (M = 15.68; SD = 0.94), belonged to different High Schools from Extremadura (Spain). Participants were measured through perception of height and weight, and were asked to select the figure that best resembled their current body size on the Stunkard's figure rating scale. Finally, the adaptation into Spanish by Moreno & Cervelló (2005) of the Physical Self-Perception Profile (Fox & Corbin, 1989) was used to measure perception of self-concept. Results The outcomes revealed normal values in perception of BMI in participants (BMI = 20.65), and Stunkard figure rating Scale. Moreover, results showed a significant relationship between perception of BMI, Stunkard's current body size and perception of self-concept. In accordance to this aspect, self-concept emerged as a strong predictor of estimated physical dissatisfaction. Discussion The results showed the importance and incidence of body size and body status in order to have a good perception of self-concept. Moreover, the results emphasized the necessity to measure perception of body mass index in great samples in adolescents. On the other hand, these outcomes highlighted the importance to have an adequate body status in order to improve psychological factors, mainly in adolescents' ages. Finally, the study concluded that current body size is a potentially useful indicator to measure weight status of adolescents. Further investigations are needed to enhance the knowledge about these relationships between perception of BMI, body dissatisfaction and self-concept. References Fox KR, Corbin CB. (1989). *J Sports Exe Psy*, 11, 408-430. Lo WS, Ho SY, Mak KK, La TH. (2012). *PLoS ONE*, 7(11). e 50017. Moreno JA, Cervelló E. (2005). *J Hum Mov Stud*, 48, 291-311. Pallan MJ, Hiam, LC, Duda, JL, Adab, P. (2011). *BMC Public Health*, 11, 21.

## Oral presentations

### OP-SH21 Sociology

#### **'YOU ARE JUST AN IDIOT FOR NOT BEING DOING ANY PHYSICAL ACTIVITY RIGHT NOW': PRE-SERVICE HEALTH AND PHYSICAL EDUCATION TEACHERS' CONSTRUCTIONS OF BODY FAT**

Varea, V.

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This paper explores how a cohort of pre-service Health and Physical Education (HPE) teachers from an Australian university describe and construct discourses about body fat. Risk and uncertainty are characteristics of our current society. In this context, it is expected for people to understand the diverse 'risks' and engage in self-monitoring strategies (Garrett & Wrench, 2012). The well known 'obesity epidemic' is a major discourse in today's society and the obesity epidemic is a clear indicative of a control society. Furthermore, panic is widely created through media campaigns using 'alarming' statistical information, mainly based in BMI levels. It has been suggested that HPE teachers usually have fat phobia tendencies (Sykes, 2009; Sykes & McPhail, 2008) and they can even transmit these beliefs and attitudes to their students (Yager & O'Dea, 2009). Taking a poststructuralist Foucauldian perspective, the aim of this paper is, therefore, to explore how these discourses about fatness have been constructed among pre-service HPE teachers and the effects that they may have on teaching practices. References Garrett, R., & Wrench, A. (2012). 'Society has taught us to judge': cultures of the body in teacher education. *Asia-Pacific Journal of Teacher Education*, 40(2), 111-126. Sykes, H. (2011). *Queer Bodies. Sexualities, gender, & fatness in physical education*. New York: Peter Lang. Sykes, H., & McPhail, D. (2008). *Unbearable Lessons: Contesting Fat Phobia in Physical Education*. *Sociology of Sport Journal*, 25, 66-96. Yager, Z., & O'Dea, J. (2009). Body image, dieting and disordered eating and activity practices among teacher trainees: implications for school-based health education and obesity prevention programs. *Health Education Research*, 24(3), 472-482.

#### **THE ECOLOGICAL HABITUS, SPORT AND PHYSICAL CULTURE**

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Recently, environmental sociology and in particular the sociology of climate change have presented strong arguments asserting the view that while climate change is a phenomenon taking place in the natural world it is social problem in so far as it is substantially caused and accelerated by unsustainable patterns of social organisation and consumption, which are forms of social behaviour. Therefore, if climate change is, in this sense a problem of social behaviour, then its mitigation and adaption are also rooted in the social with all forms of sport and physical culture centrally implicated in any attempts at change. However, one of the enduring problems rests with conceptualisations of social behaviour, which have tended towards either overly cognitive behaviourist or individualist explanations and applications, each of which presuppose intellectually determinist or voluntarist leanings respectively. This paper explores an alternative view of (un)sustainable social behaviour that stresses embodied beliefs and social practices emerge from prolonged engagement in sociocultural fields of activity such as particular sports and physical cultures. In so doing it identifies the 'ecological habitus' as articulated by Kasper (2009: 322) as a continuum of dispositions ranging from the 'ecologically supportive to antagonistic'. It is argued that this approach allows researchers to map the alignment between the core dispositions of a given sport or physical culture with dispositions of an ecologically supportive or antagonistic habitus. Better understanding this (mis)alignment will provide clearer picture of the specific dispositions and their related social practices that might need addressing or reinforcing if sustainable social behaviour in sport and physical culture is to become a more widespread reality.

#### **SPORT AS A RESPONDING SOLUTION TO SOCIAL PROBLEMS? CONTEXTUALIZING SPORT AND WELFARE**

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Sport have in recent decades gained more and more attention in social policy as a means of responding to social problems. This role ascribed to sport have been studied in various disciplines foremost in a US and UK context. The issue has thus far received poor attention in Swedish research. This presentation targets some considerations on the design of three interrelated studies constituting the main body of a forthcoming doctoral thesis on sport as a responding solution to social problems. First, it is noted that Swedish research disregard a distinction between social objectives as a premise of sport (so called Plus Sport) or as an effect from sport. As a consequence, there is a lack of research on Plus Sport practices, something which my research intends to redress. Moreover, Swedish research is empirically driven but however vaguely related to the historical and political context within which sport have emerged in this seemingly new role. Second, such observations call for further theoretically informed research relating contemporary sport practices with social objectives to the transformations in welfare provision of recent decades. Third, as a result two studies focusing on a Plus Sport program (SP) responding to the observed gaps in research were designed. The SP is a local welfare intervention initiated by municipal public authorities in partnership with a social entrepreneur and local voluntary sport clubs in a larger Swedish city targeting crime and segregation. Statements on sport as a responding solution to social problems articulated by social entrepreneur representatives and by municipal policy makers is examined from a constructionist strand. In short, one study focuses on the pedagogical governing techniques promoted within the SP by the social entrepreneur representatives as well as what kind of desirable citizen subjects the SP aim to produce. The other study focuses on the organizational side of the SP concerning the policy makers conceiving of sport in relation to state-centered public welfare provision and civil society and market involvement. The presentation aims to discuss the design of the latter two studies with respect to potential blind spots and its' contribution to research on sport's role in society and welfare provision.

## HEALTH COMMUNICATORS' ALTERING THEIR PRACTICE BY IMPLEMENTING PHYSICAL ACTIVITY FOR NEWLY ARRIVED REFUGEES

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Introduction Swedish experience has shown that health problems contribute to a slower, and longer integration process among newly arrived refugees (Povrzanovi Frykman et.al.2011). Health is crucial for learning, integration and establishment in the labour market for these groups. Physical activity presents itself as a possible way to develop and maintain both physical and mental health among refugees, thus facilitating their integration process. Within Sweden, more broadly, 'communicators', who are previous refugees themselves, work with recent arrivals to educate and inform about the Swedish society. Within the province of Scania, a recent initiative has been introduced where the communicators also inform about health issues, including the promotion of physical activity and recreation for active living. The concept of working with and through physical activity is new in this context for the health communicators (HC). Understanding the working methods among HC in Scania is important, not only because of their central role in the re-settlement programme, but also because of the new methodologies surrounding physical activity that HC are having to engage with. Methodology Action Research (AR), with its focus on understanding and improving professional practice was adopted for the current project. Data was collected through, open ended interviews, observations, field notes and participation in the field. The data was read through the lens of 'practice theory' with a particular focus on practice architecture (Kemmis & Grootenboer, 2008). This framework allowed for a focus on the 'doings' 'sayings' and 'relatings'. Results and Discussion Practice architectures was used as a theoretical framework in order to understand what constitutes and affects a practice. The relationships between material-economic, social-political and the culture-discursive structures determine the HC opportunities for professional practice. The HC expressed the need for increased co-operation within and between national and local departments involved in the receiving of refugees. This is especially important if health promotion is to be central within the refugee establishment process. Conclusion There is great value for newly arrived refugees to meet in different health-promoting locations and to engage in physical activities on a practical level. For sustainable health promotion among refugees to become reality it is required that different authorities cooperate with the HC on a more concrete level than is the case today. References Povrzanovi Frykman, M., & Skaffari-Multala, M. (2011). Retrieved from <http://www.mah.se/upload/Forskningscentrum/MIM/MIM/MIM%20Academic%20rec%20FINAL%20January%20webb.pdf> Kemmis, S., & Grootenboer, P. J. (2008). Situating praxis in practice <https://www.sensepublishers.com/>.

## Oral presentations

### OP-PM62 Health & Fitness: Mixed

#### SELF-ADMINISTERED PHYSICAL EXERCISE TRAINING AS TREATMENT OF NECK PAIN AMONG MILITARY HELICOPTER PILOTS AND CREW – A RANDOMIZED CONTROLLED TRIAL

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Introduction: Flight related neck pain is frequent among helicopter pilots and crew and affect individual health, operational capacity and flight safety. Exercise training has proven effective in reducing neck pain within other job professions. The aim of this study was to investigate if an exercise intervention might reduce neck pain among helicopter pilots and crew. Methods: A total of 31 helicopter pilots and 38 crew members were randomized to an exercise-training-group ETG (n=35) or a reference-group REF (n=34). ETG received 20 weeks of strength, endurance and coordination training targeting the deep and superficial neck muscles. Training was self-administered due to irregular work schedules. REF received no training. Primary outcome: Intensity of neck pain the previous 3 months (self-reported on a 0-10 numeric box scale) and pressure-pain threshold (PPT) in the trapezius m. (TRA) and upper neck extensors (UNE). Secondary outcome: Maximal voluntary contraction (MVC) for cervical extension/flexion and shoulder elevation. Training compliance was self-reported and categorized as regular if performed  $\geq 1$  times a week. Results: Neck pain at baseline was  $1.9 \pm 1.7$  (mean  $\pm$  SD) in ETG and  $2.5 \pm 1.9$  in REF, and PPT in TRA and UNE (right/left)  $424 \pm 187/434 \pm 188$  kPa,  $343 \pm 153/366 \pm 161$  kPa in ETG and  $416 \pm 177/405 \pm 163$  kPa,  $334 \pm 147/329 \pm 144$  kPa in REF. Intention-to-treat analysis revealed no significant effect on self-reported pain between groups. Within ETG PPT in left TRA was significantly reduced at follow-up:  $381 \pm 169$  kPa ( $p=0.009$ ). Also, within REF PPT was significantly reduced in TRA and UNE at follow-up (right/left)  $342 \pm 143$  kPa ( $p=0.003$ ) /  $331 \pm 154$  kPa ( $p=0.001$ ),  $294 \pm 116$  kPa ( $p=0.024$ ) /  $291 \pm 121$  kPa ( $p=0.035$ ). Per-protocol analysis for pain in ETG, only including subjects who trained regularly ( $n=10$ ), was  $2.2 \pm 0.6$  at baseline and  $1.3 \pm 1.3$  at follow-up, but not significantly different from REF. MVC for cervical extension/flexion was in ETG  $248 \pm 64/184 \pm 60$  N at baseline and  $261 \pm 56/194 \pm 63$  N at follow-up, and correspondingly for REF  $241 \pm 60/174 \pm 52$  N and  $226 \pm 58/175 \pm 43$  N. MVC for cervical extension was significantly improved in ETG compared to REF ( $p=0.016$ ). Discussion: Specific neck training significantly increased MVC in UNE in ETG. Also, PPT decreased significantly in left TRA in ETG and in REF in both TRA and UNE. No significant difference was observed between groups for self-reported neck pain. This may be due to low compliance since only  $\sim 1/3$  of subjects in ETG engaged in regular training. E-mail: [mmurray@health.sdu.dk](mailto:mmurray@health.sdu.dk)

#### CARDIAC AUTONOMIC CONTROL INDEPENDENT ASSOCIATIONS WITH CARDIORESPIRATORY FITNESS AND RESTING METABOLIC RATE IN NAFLD PATIENTS

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Introduction Parasympathetic control of heart rate is dominant at rest. Heart rate recovery (HRR) after exercise, a marker of parasympathetic reactivation, is associated with cardiorespiratory fitness (CRF). Body composition (BC), particularly body fat (BF) distribution is highly related with HRR in Non-Alcoholic Fatty Liver Disease (NAFLD) patients. The association of HRR with both CRF and resting metabolic rate (RMR) is not yet known in NAFLD patients. The aim of this study was to determine if HRR is independently associated with CRF and RMR, and if such associations were influenced by markers of BC, in NAFLD patients. Methods We assessed 28 NAFLD patients (19 males, 51 +

13 yrs, and 9 females, 47 + 13 yrs), who were diagnosed through liver biopsy or ultrasound. All subjects underwent both RMR and treadmill maximum graded exercise testing (GXT) assessment with indirect calorimetry and 12 lead ECG and. RMR was expressed as kcal/day and CRF was assessed as the maximal oxygen uptake (ml/kg/min) in the GXT. HRR was the difference between peak exercise heart rate (HR) and the HR at 1 (HRR1) and 2 minutes (HRR2) immediately after GXT. BC assessment consisted of anthropometry, specifically: weight, height, waist circumference (WC), body mass index (BMI) and waist-to-height ratio (WHtR). Partial correlations were used to test associations. Only  $r \geq 0.5$  were considered to attain statistical significance ( $\alpha=5\%$  and  $\beta=20\%$ ). Results HRR1 and HRR2 were associated with CRF ( $r=0.63$  and  $r=0.52$ ; respectively,  $p<0.01$ ), as were WHtR and WC ( $r=0.69$  and  $r=0.64$ ; respectively,  $p<0.01$ ), but not BMI ( $r= -0.25$ ,  $p=0.243$ ), controlled for age and sex. When controlling also for BMI, both HRR1 and HRR2 were still related with CRF ( $r=0.64$  and  $r=0.54$ ; respectively,  $p<0.01$ ). The relation with CRF, when controlled for age and sex plus WC or WHtR, was absent both for HRR1 ( $r=0.43$  and  $r=0.45$ ;  $p=0.050$  and  $p=0.041$ ) and HRR2 ( $r=0.34$  and  $r=0.38$ ;  $p=0.110$  and  $p=0.081$ ). HRR1, HRR2 and all studied BC markers were not related with RMR in these NAFLD patients, despite the control variables used. Discussion HRR was found related with CRF in NAFLD patients, though not independently of BC, specifically central BF accumulation markers. The relation between HRR and CRF may be mediated by BC in NAFLD patients. HRR was not related to RMR. Thus, exercise-related cardiac autonomic control does not appear to influence RMR.

## THE EFFECT OF PHYSICAL FITNESS AND PHYSICAL EXERCISE TRAINING ON WORK PRODUCTIVITY AMONG HEALTH CARE WORKERS

Kongstad, M., Sjøgaard, G., Sjøgaard, K., Christensen, J.R.

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**Introduction** Workplace health promotion involving physical exercise training may negate lifestyle diseases and improve work productivity (WP) mediated by physiological variables such as BMI, cardiorespiratory fitness (CRF), and maximal voluntary contraction (MVC). The aim of this paper was to examine 1) the relationship between WP and the physiological variables BMI, CRF, and MVC in a cross-sectional sample of health care workers, as well as 2) the change in WP in relation to changes in the before mentioned physiological variables following workplace health promotion. **Methods** Secondary analyses were performed on a subsample of 139 female health care workers in Denmark participating in a cluster randomized controlled trial (Holtermann et al. BMC Public Health 2010, 10:120). WP was assessed as a summed score using selected, validated questions from three questionnaires (Health and Work Performance Questionnaire, Work Ability, and Quantity and Quality Method). Height and weight were measured to calculate BMI, CRF was measured using a bicycle ergometer maximal exercise test, and MVC was measured during arm abduction, shoulder elevation, back flexion and extension using a Bofors dynamometer. Partial correlation as well as one-way analysis of variance with Tukey HSD post-hoc testing was used for analyses. **Results** Cross-sectional analyses at baseline showed a significant relationship between WP and strength in back flexion ( $r = .28$ ,  $p = .03$ ) and back extension ( $r = .32$ ,  $p = .02$ ) as well as an inverse relationship between WP and BMI ( $r = -.22$ ,  $p = .02$ ). Also, the group of participants with BMI > 30 had significantly lower WP than the group with BMI < 25 ( $p = .04$ ). Over a period of three months a subgroup of the participants had participated in health promotion, and a significant positive relationship was found between change in WP and changes in strength in back flexion ( $r = .46$ ,  $p = .005$ ) and back extension ( $r = .41$ ,  $p = .01$ ). A significant inverse relationship between change in WP and change in BMI ( $r = -.33$ ,  $p = .004$ ) was found. No corresponding relationships were found between WP and CRF or strength in arm abduction and shoulder elevation. **Discussion** The present study is the first to examine the relationship between WP and MVC, as well as among the first to examine the relationship between WP and CRF. Results from the present study suggest that increased WP in health care workers may be attained by lowering BMI as well as increasing the strength in back flexion and extension. The prospect of increased WP may increase enthusiasm among employers towards introducing workplace health promotion, which could result in healthier employees and reduced costs for both the employers and national health services. Contact mbkongstad@gmail.com

## EFFECTS OF ACUTE EXERCISE ON BRAIN MECHANISMS ASSOCIATED WITH SINGLE- AND DUAL-TASKS DURING LOCOMOTION

Duncan, S., Panchuk, D., Schneider, S., Polman, R.C.J.

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**Introduction:** Numerous studies have examined behavioural outcomes, such as task completion time and/or errors made, when we execute a single-task (e.g., locomotion) or dual-task (e.g., locomotion while counting backwards). Yet few studies have examined the neural mechanisms that underlie behavioural differences in the execution of single- and dual-tasks or whether acute exercise can alter these mechanisms. This study examined the effects of two different forms of acute exercise on neural activity while individuals performed a locomotor (single) task or locomotor task and cognitive, decision making (dual) task. **Method:** In a randomized, cross-over design, 15 participants (7 M, 8 F; mean age: 27.3 years) performed single and dual-tasks prior to and following an acute bout of exercise. In the single task condition participants walked around a grid-based track travelling in different directions at each junction. Direction of travel was determined by a stimulus that required the participant to turn left (green light), turn right (red light), or continue straight ahead (no light). In the dual-task condition participants performed the same locomotor task while concurrently performing a memory task (remembering a shopping list). Neural activity was recorded before and after exercise using wireless EEG during all tasks; analyses were conducted using sLORETA (standard low-resolution brain electromagnetic tomography; Pascual-Marqui, 2002) of the ERP N2 and P3. The acute bouts of exercise required either a 45 min bout of aerobic exercise (cycling at 60 – 70%  $VO_{2max}$ ) or 45 min of upper and lower body strength training (12 reps x 3 sets at 65 – 75% of the 1RM) separated by 1-week. **Results:** Preliminary results of sLORETA analyses showed a significant increase after the aerobic bout of exercise in N2 ( $p < 0.01$  post exercise measurements, single and dual task conditions compared to baseline) as well as an increase in the P3 in the single and dual task conditions compared to baseline ( $p < 0.01$  and  $p < 0.05$  respectively). **Discussion:** We suggest that the differences observed between conditions indicate an increased motor network coherence (functional connectivity) resulting in improved performance and/or that a more efficient allocation of attentional resources was necessary to perform a more complex and attention demanding task. **References** Pascual-Marqui, R. D. (2002). Standardized low-resolution brain electromagnetic tomography (sLORETA): Technical details. *Methods and Findings in Experimental and Clinical Pharmacology*, 24(SUPPL. D), 5-12

**BREAKING UP PROLONGED SITTING TIME DOES NOT AFFECT APPETITE OR GUT HORMONE CONCENTRATIONS IN SEDENTARY ADULTS**

Bailey, D.P., Broom, D.R., Christmas, B.C., Taylor, L., Flynn, E., Hough, J.P.

*University of Bedfordshire*

Introduction: Exercise influences the release and metabolism of appetite-regulating hormones, suppressing appetite during and following a single continuous bout of high-intensity exercise. Engaging in prolonged sitting has received overwhelming attention recently following evidence that this results in deleterious metabolic consequences. Breaking up sitting time with frequent, brief bouts of activity can negate these deleterious effects but the influence on appetite and gut hormone concentrations is unknown. Methods: 13 sedentary (7 female), inactive participants took part in three, 5 h trials in random order: 1) uninterrupted sitting (SIT), 2) seated with 2 min bouts of light-intensity walking every 20 min (SIT+LA), and 3) seated with 2 min bouts of moderate-intensity walking every 20 min (SIT+MA). A standardised test drink was provided after an initial 1 h period of uninterrupted sitting. Appetite ratings were taken at 30 min intervals and blood samples taken hourly to measure plasma concentrations of acylated ghrelin, peptide YY, glucagon-like peptide-1, insulin, and glucose. Total area under the curve (AUC) was calculated for each variable. An ad libitum pasta test meal was provided at the end of each trial. Results: AUC values for appetite ratings and gut hormone concentrations were unaffected by frequent brief bouts of activity compared with uninterrupted sitting (linear mixed modelling:  $p > 0.05$ ). Glucose and insulin concentrations also did not differ significantly over the 5 h trial period ( $p > 0.05$ ), nor was there any difference in absolute ad libitum energy intake during the post-trial test meal ( $p > 0.05$ ). However, relative energy intake (energy intake minus the net energy expenditure of exercise) was lower in the SIT+LA and SIT+MA trials than in the SIT trial (SIT,  $441 \pm 296$  kcal; SIT+LA,  $298 \pm 254$  kcal; SIT+MA,  $111 \pm 151$ ;  $p < 0.05$ ). Conclusion: Appetite and gut hormone responses to a meal are not altered over a 5 h period with frequent short bouts of light- or moderate-intensity walking. Increased energy expenditure from intermittent activity could promote an energy deficit that is not compensated for in a subsequent meal. Contact: daniel.bailey@beds.ac.uk

**SEQUENTIAL AND ALTERNATING PHYSICAL EDUCATION DIDACTIC UNITS WITH TEAM VS. INDIVIDUAL SPORTS – EFFECTS ON PHYSICAL FITNESS**

Póvoas, S.1,2, Silva, P.2,3, Lopes, M.2, Krstrup, P.4,5

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Introduction In physical education (PE) classes, teachers can choose between sequential or alternating planning of the didactic units throughout each of the three school trimesters. In sequential planning a team sport is used during the first half of the trimester followed by an individual sport (TS/IS) during the second half (or vice-versa, i.e., IS/TS). In alternating planning, team and individual sports are alternating in the two PE sessions conducted each week (TS-IS), one lasting 60 min and other 90 min. The purpose of this study was to analyse the effects of sequential and alternating planning on pupils' physical fitness. Methods Two hundred and two pupils from 7th, 8th and 9th grade (12-16 years) participated in this study. Three classes from each grade were cluster-randomized into the three types of planning: TS/IS, IS/TS and TS-IS. Football was the chosen team sport and gymnastics the individual sport. Evaluations were performed at the beginning, middle and end of a school trimester. Aerobic fitness was assessed by the Yo-Yo intermittent endurance level 1 test (YYIE1) (1), leg muscle power by the countermovement jump and postural balance by a single-legged Flamingo balance test (2). Continuous heart rate monitoring and rating of perceived exertion were used to evaluate the exercise intensity during PE classes. Results Aerobic fitness and postural balance significantly increased during team sport classes and significantly decreased during individual sport, when evaluating the planning types TS/IS and IS/TS ( $p \leq 0.05$ ). Leg muscle power significantly increased during team sport classes ( $p \leq 0.05$ ). Alternating between team and individual sports in PE classes within each week had no significant effect on pupils' physical fitness levels. Discussion In accordance with previous studies (3), these study results show that team sports (football) can improve pupils' physical fitness during short-term interventions, probably due to a combination of high aerobic loading and multiple specific intense actions like sprints, turns, dribbles, tackles, jumps and shots. The present data also suggest that some of the individual sports currently chosen for PE are not sufficiently intense to improve the fitness profile of 12-16-year-old school children. References 1.Bangsbo, J. (1994). Fitness Training in Football: A Scientific Approach. Bagsvaerd: HO & Storm. 2.Deforche, B. et al. (2003). Obesity Research, 11(3), 434-441. doi:10.1038/oby.2003.59 3.Bendixsen, M. et al. (2014). Eur J Sport Sci, 14(8), 861-869. doi:10.1080/17461391.2014.884168.

**Oral presentations****OP-PM72 Molecular Biology and Biochemistry: Gene expression & signaling****EFFECT OF ACUTE INTERVAL EXERCISE ON OXIDATIVE STRESS IN CANOEISTS**

Chien, L., Lee, T., Lu, K., Li, T.

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Introduction Canoeists are usually trained via the pattern of intensely interval training. However, it is still unknown if the pattern-induced stress influences oxidative stress. The purpose of this study was to investigate the effect of acute interval exercise on oxidative stress in canoeists. Methods Nineteen healthy male canoeists (age  $16 \pm 2$  yr, height  $172.0 \pm 5.8$  cm, weight  $63.3 \pm 7.4$  kg, mean  $\pm$  SD) participated in this study. The subjects completed a single interval training session (six 90-sec bouts of high-intensity rowing separated by 4 min recovery period). Blood samples were taken at pre-exercise, post-exercise, and 3 hours post-exercise for analyzing plasma levels of thiobarbituric acid reactive substances (TBARS), superoxide dismutase activity (SOD), and catalase activity (CAT). Repeated one-way ANOVA was adopted and statistical significance was set at  $\alpha = 0.05$ . Results The results of this study showed that the TBARS levels at post-exercise ( $2.88 \pm 0.74 \mu\text{M}$ ) were significantly higher than pre-exercise ( $2.43 \pm 0.57 \mu\text{M}$ ) and returned to baseline at 3 hours post-exercise ( $2.43 \pm 0.56 \mu\text{M}$ ). A trend was found that SOD activity was increased with time, but only the levels at 3 hours post-exercise ( $4.72 \pm 3.14 \text{ U/ml}$ ) were significantly higher than pre-exercise ( $3.49 \pm 2.12 \text{ U/ml}$ ). The CAT activity at post-exercise ( $663.86 \pm 173.12 \text{ U/ml}$ ) was significantly higher than pre-exercise ( $475.19 \pm 146.79 \text{ U/ml}$ ) and decreased significantly at 3 hours post-exercise ( $329.12 \pm 110.42 \text{ U/ml}$ ). Discussion The main results of this study are similar to previous findings. Ji et al. (2010) indicated that exercise-induced reactive oxygen species could



improve antioxidant system to increase antioxidant enzymes and called it hormesis. Subsequently, studies reported that TBARS levels were significantly increased after an acute session of hypertrophy resistance interval exercise (Deminice et al., 2011). Furthermore, TBARS and CAT levels were significantly elevated after a short-term high-intensity interval exercise (four to six 30-sec bouts of high-intensity cycling separated by 4 min recovery period) (Boqdanis et al., 2013). The findings of this study suggested that acute interval exercise increased the oxidative stress and subsequently improved antioxidant capacity to blunted oxidative damage. References Bogdanis GC, Stavrinou P, Fatouros IG, Philippou A, Chatziniolaou A, Draganidis D, Ermidis G, Maridaki M. (2013). *Food Chem Toxicol*, 61, 171-7. Deminice R, Sicchieri T, Mialich MS, Milani F, Ovidio PP, Jordao AA. (2011). *J Strength Cond Res*, 23(3), 798-804. Ji LL, Dickman JR, Kang C, Koenig R. (2010). *Dose Response*, 8(1), 73-9. Contact E-mail address: lee@ntsu.edu.tw (Dr Tzai-Li Li)

### **EFFECTS OF A SINGLE RESISTANCE EXERCISE BOUT ON NF- $\kappa$ B SIGNALLING IN SKELETAL MUSCLES OF MASTERS WEIGHTLIFTERS AND AGE-MATCHED CONTROLS**

Wessner, B., Hofmann, M., Ploder, M., Tschan, H., Bachl, N.

*University of Vienna*

**Introduction** Masters athletes who continue a regular, performance-oriented training throughout life provide a unique model for studying successful aging as changes observed in master athletes are considered the results of primary (physiological) rather than secondary (lifestyle) ageing [1]. With this in mind, the current study aimed to compare the effects of an acute resistance exercise on Nf- $\kappa$ B signalling (known to be a key regulator of inflammatory pathways) in the muscles between trained masters weightlifters and healthy untrained individuals. **Methods** Sixteen older men (8 masters weight lifters (WL), 8 age-matched controls (CO)) volunteered to participate in the study (61.2  $\pm$  8.2 years, height: 1.73  $\pm$  0.07 m, weight: 77.9  $\pm$  14.0 kg, BMI: 26.0  $\pm$  3.9 kg/m<sup>2</sup>). Two days after assessing 1-RM, an acute exercise protocol (3 sets, 70-75% of 1-RM until voluntary fatigue) was applied unilaterally on the dominant leg while the other leg served as control. Three hours after termination of the exercise, skeletal muscle tissue was obtained via percutaneous biopsy of m. vastus lateralis from both legs and subjected to gene expression analyses using the human Nf $\kappa$ B Signaling Pathway RT<sup>2</sup> Profiler™ PCR Array (SABiosciences). Promising results were confirmed by q-PCR. In order to test the main study hypothesis, interactions between training status (WL, CO) and resistance exercise (exercised leg, resting leg) were tested by two-way ANOVA with repeated measures. **Results** The results of the Nf- $\kappa$ B PCR array demonstrated only marginal differences in gene expression levels between WL and CO in both, the exercised and the non-exercised legs. Acute resistance exercise led to an up-regulation (> 1.5-fold) of 14 genes in CO and of 13 genes in WL. The transcription factors FOS and early growth response 1 (EGR1) comprised the most responsive genes to resistance exercise (EGR1:15.7-fold increase, p=0.003, FOS: 36.3-fold increase, p<0.001) but no group or interaction effects could be detected (p>0.05). **Discussion** With this study we confirm previous data showing that resistance exercise triggers a subclinical inflammatory response that is thought to play an important role in skeletal muscle regeneration [2]. We could not confirm our initial hypothesis that this response would be different in trained and untrained elderly. However, it has to be considered that the sample size was quite small. Furthermore, we focused on the immediate response in gene expression. It cannot be excluded that differences would be present at later time points [3]. **References** [1] Tanaka & Seals (2003) *J Appl Physiol*, 95(5):2152-62 [2] Vella L et al. (2014) *Physiol Rep*, 2(10):e12172 [3] Paulsen G et al. (2012) *Exerc Immunol Rev*, 18:42-97 Contact barbara.wessner@univie.ac.at

### **THE EFFECTS OF AEROBIC EXERCISE ON NF- $\kappa$ B, LIN 28B AND LET-7A MICRORNA EXPRESSIONS AND LEVELS OF TUMOR TISSUE IL-6 IN MICE WITH BREAST CANCER**

Anoosheh, L., Kordi, M.R., Gaeini, A.A., Mahdian, R., Mirakhori, Z., Amani Shalamzari, S.

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**Introduction** Inflammatory response has a pivotal role in tumorigenesis, progress and metastasis of most cancers particularly breast cancer (Taniguchi and Karin 2014). An epigenetic switch, from normal breast cell to cancer, is activated by an inflammatory signal, and epigenetic inheritance is mediated by a positive feedback loop involving Nf- $\kappa$ B, Lin28B, let-7a and IL-6 (Iliopoulos et al. 2009). The aim of the present research was to assess the effects of 6 weeks of aerobic exercise on Nf- $\kappa$ B, Lin28B, let-7a microRNA, and IL-6 of tumor tissue of mice with breast cancer. **Method** 20 female BALB/c mice (4 to 5 weeks old) were inoculated with MC4-L2 estrogen receptor positive breast cancer cells. They were, then, divided into two groups of Tumor-Exercise (TE)(n=10) and Tumor-Control (TC)(n=10). TE group performed aerobic exercise five days per week for six weeks. After emergence of tumor, the widths and the lengths of the tumors were weekly measured by digital caliper. Mice were sacrificed 48 hours after the last exercise session and tumor tissue was removed. Nf- $\kappa$ B, Lin28B and miRNA let-7a gene expression were quantified with Real time-PCR and tumor tissue IL-6 was measured by ELISA test. Repeated measures ANOVA and independent t tests were used to assess tumor size and IL-6, respectively. Statistical analysis of Nf- $\kappa$ B, Lin28B and let-7a were performed by REST software. **Results** Tumor volume, expression of Nf- $\kappa$ B and Lin28B genes and IL-6 levels diminished significantly in TE group compared with TC group, but let-7a microRNA showed a significant increase (P<0.05). **Discussion** In the present investigation, diminution of tumor volume in TE group compared to TC is observed following aerobic exercise training. Inflammatory status is one of the mechanisms involved in growth of tumor; it has been demonstrated that aerobic exercise can reduce this status. In present research it is shown that the levels of IL-6 diminished significantly following aerobic exercise training and seems to be effective in decreasing tumor volume. The results of the present investigation also demonstrate that regular aerobic exercise could have an effective role in diminution of Lin28B and Nf- $\kappa$ B and increase of microRNA let-7a. As it has been demonstrated that perturbation of any component of the regulatory circuit (inhibition of Nf- $\kappa$ B or Lin28B or IL-6 or over-expression of let-7a) could induce significant reduction of tumor growth and mortality in breast cancer (Iliopoulos et al. 2009), it could be claimed that regular aerobic training can at least have a therapeutic role in estrogen-receptor-dependent breast cancers. However more studies are needed to be conducted. **References** Iliopoulos D., Hirsch HA., Struhl K. (2009) An epigenetic switch involving Nf- $\kappa$ B, Lin28, Let-7 MicroRNA, and IL6 links inflammation to cell transformation. *Cell*. 139(4):693-706. Taniguchi K., Karin M.(2014) IL-6 and related cytokines as the critical lynchpins between inflammation and cancer, *Seminars in Immunology*, 26(1): 54-74. Contact Email address: L.anosheh@ut.ac.ir

**DEGRADOME EXPRESSION PROFILING IN STRAINED AND PATHOLOGICAL TENDON – ARE THERE COMMON PATTERNS IN EXERCISE AND TENDINOPATHY?**

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Introduction The exact mechanisms leading to tendinopathies and tendon ruptures remain poorly understood while their occurrence is clearly associated with exercise. Overloading is thought to be a major factor contributing to the development of tendon pathologies. However, as animal studies have shown, heavy loading alone won't cause tendinopathies. It has been speculated, that malfunctioning adaptation or healing processes might be involved, triggering tendon tissue degeneration. By analysing the expression of the entirety of degrading enzymes (degradome) in pathological and non-pathological, strained and non-strained tendon tissue, the aim of this study was to identify common or opposite patterns in gene regulation. This approach may generate new targets for future studies. Methods RNA was extracted from different tendon tissues: normal (n=7), tendinopathic (n=4) and ruptured (n=4) Achilles tendon; normal (n=4) and tendinopathic (n=4) posterior tibialis tendon; normal hamstrings tendon with or without subjection to static strain (n=4). The RNA was reverse transcribed, then pooled per group. The expression of 538 protease genes was analysed using Taqman low-density array quantitative RT-PCR. To be considered relevant changes had to be at least 4fold and measurable at a level below 36 Cts. Results In general, there was little common regulation when exercised was compared with pathological tissue. The expression of PAMR1 and TNFAIP3 was upregulated with both exercise and Achilles tendon pathology, while DDIT1, PSMB11 and PSH5 which were down-regulated with exercise were upregulated with Achilles pathology. However, 69% of genes regulated in Achilles tendinopathy were also regulated in the same way with Achilles tendon rupture, while only 12% were similarly regulated in posterior tibialis tendinopathy. Discussion The incongruent protease expression pattern in Achilles and posterior tibialis tendinopathy, as previously shown for members of the IL6 family (Legerlotz et al. 2012), indicates substantial differences in pathological processes. The newly found targets may deliver insights into the initiation and progression of tendon pathologies. Our data indicate, that the overexpressed PAMR1, a regeneration associated muscle protease which has been shown to be downregulated in Duchenne muscular dystrophy and upregulated in regenerating muscle fibers (Nakayama et al. 2004), is also involved in tendon regeneration. References Legerlotz et al. (2012) *Rheumatology*, 51(7):1161-5 Nakayama et al. (2004) *Am J Pathol*, 164(5):1773-82

**Oral presentations****OP-PM34 Sports Medicine & Orthopedics: Injury prevention II****COMPARISON OF MECHANICAL INJURY RISK FACTORS BETWEEN MALE AND FEMALE WORLD CUP ALPINE SKIERS IN THE DISCIPLINE SUPER-G**

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Introduction Alpine ski racing is considered a sport with high injury risk. Most injuries per run occur in the speed disciplines downhill (DH) and super-G (SG). In World Cup SG skiing 14 male and 7 female athletes get injured per 1000 runs (Florenes et al., 2009). Recent studies have shown that injury risk in SG and DH is related to speed, race duration and jumps (Gilgien et al., 2014). However, such investigations were undertaken for male skiers only. The mechanics of female alpine skiers is largely unknown and therefore also their relation to injury risk. Therefore this study compares—for the first time—mechanical injury risk factors of a female World Cup alpine skier to a male World Cup alpine skier when skiing on the same SG course. Methods One male and one female skier with similar performance levels compared to the world best within their sex (male: 5.42 FIS points, ranked 26; female: 5.99 FIS points, ranked 30) skied 6 runs each on a SG race simulation. The skiers were equipped with a differential global navigation satellite system (dGNSS) tracking the skiers head trajectory at a frequency of 50Hz (Gilgien et al., 2015b). The snow surface of the course was captured by static dGNSS and a digital terrain model was reconstructed (Gilgien et al., 2015a). The digital terrain model in combination with a virtual pendulum model attached to the helmet trajectory was used to compute the center of mass position, speed, kinetic energy and the ground reaction force (GRF) (Gilgien et al., 2013). Finally, mean and standard deviation of the parameters for the runs within sex were computed. 1RM back squat strength as measured as a part of the athletes' normal test program. Results The male skier had a 5.0±0.6% higher mean speed compared to the female skier (28.9±0.1 vs 27.5±0.2 m/s), and as a consequence 9.7% higher kinetic energy on average. While mean GRF was similar (1.48±0.01 body weight (BW) and 1.42±0.01 BW for the male and female, respectively) while 1 RM back squat strength was substantially greater for the male skier (2.3 BW and 1.7 BW for the male and female athlete, respectively, a difference of 35%). Discussion When skiing in the same course male skiers might be able to compensate increased injury risk due to GRF and kinetic energy involved in crashes with superior physical strength. The decreased injury risk for female skiers might therefore be related to less dangerous characteristics of female courses. References Florenes, T. et al. (2009). *Br. J. of Sports Med.* Gilgien, M., et al. (2013). *Sensors*. Gilgien, M., et al. (2014). *Br. J. of Sports Med.* Gilgien, M., et al. (2015a). *PlosOne*. Gilgien, M., et al. (2015b). *J. Sport Science*. Contact matthias.gilgien@nih.no

**CONTACT INJURIES OF THE FEMALE FIELD HOCKEY PLAYERS**

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Introduction Field hockey is classified as a non-contact sport, however it is clear from literature review that most injuries occur by contact. Despite the old history of the sport, field hockey has only recently started to develop in Turkey. This is the first research about the field hockey injuries which take place especially due to contact. The aim of this study was to evaluate the types of contact injuries, number of occurrences, body parts injured, and contact mechanism of injury with positions of players. Methods 96 Turkish female field hockey players took part in this study and they filled an anonymous questionnaire including field hockey information (position, and playing experience) and contact injury history of players in the 2011-2012 season (numbers of contact injuries, type of injuries, contact mechanism of injuries and detailed body parts injured with positions of players). The statistical analysis was carried out using SPSS 11.0. software. Chi-square test was used to determine whether there were significant differences between selected variables. To determine the average risk of injury of the players according to their positions, average injury rate was calculated by the total number of injuries of players/according

to playing position number of players. Results The most common type of injury was contusion (50% of the total 382 contact injuries). Injuries caused by the contact of the ball are the main reasons of such injuries and they constitute 46% of the contact injuries. Besides, it was found out that the body part affected most commonly by contact injuries is the upper limb (48%). Defenders have the highest rate of contact injury as common as 41%. There were significant differences between types of injuries and mechanisms of the contact injuries ( $p=0,001$ ). Discussion As a result of, it was concluded that more protective clothes and equipment would make contact injuries less common and probably make field hockey more popular. The regular and systematic data collection about sport injuries will improve the prevention and control of these injuries.

### **PROTECTIVE EFFECT BY MAXIMAL ISOMETRIC CONTRACTIONS AGAINST MAXIMAL ECCENTRIC CONTRACTION-INDUCED MUSCLE DAMAGE OF THE KNEE EXTENSORS**

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**Introduction** It has been reported that 30 maximal voluntary isometric contractions (MVIC) at a long muscle length (20° elbow flexion) that induced little changes in indirect muscle damage markers conferred potent protective effect against muscle damage after 30 maximal eccentric contractions (MaxEC) of the elbow flexors (EF) performed 3 weeks later [1]. However, no previous studies have examined whether the protective effect of MVIC is evident for other muscles such as the knee extensors (KE). Since KE are major muscles used in our daily activities, exercise and sports, it is important to determine whether the findings based on the EF are applicable for the KE. It may be that MVIC would not confer protective effect for KE. This study investigated whether 60 MVIC performed 2 weeks before 60 MaxEC would attenuate the magnitude of muscle damage of the KE. **Methods** Twenty-six untrained men ( $21.0 \pm 1.2$  y) were assigned to an experimental (EXP) and control (CONT) groups ( $n=13/\text{group}$ ). The subjects in the EXP group performed 6 sets of 10 MVIC at 90° knee flexion 2 weeks before 6 sets of 10 isokinetic (30°/s) MaxEC, but the subject in the CONT group performed MaxEC without MVIC. Maximal concentric strength (MVC-CON) of the KE, range of motion (ROM), upper thigh circumference, plasma creatine kinase activity and myoglobin concentration, muscle soreness (SOR) and echo intensity of B-mode ultrasound images were measured before, immediately after and 1-5 days after MVIC and MaxEC, and the changes in the variables after MaxEC were compared between the groups by a two-way repeated measures ANOVA. Results Significant but small changes ( $P<0.05$ ) in MVC-CON, ROM and CK were evident immediately to 2 days after MVIC, but they returned to the baseline by 3 days after MVIC. No significant differences in the baseline muscle damage markers were found before MaxEC between the groups. All variables changed significantly after MaxEC, but the changes were smaller and the recovery was faster for EXP than CONT group ( $P<0.05$ ). **Discussion** These results showed that MVIC of the KE conferred potent protective effect against muscle damage induced by MaxEC performed 2 weeks later. The magnitude of effect appears to be similar to that has been shown for the EF in the previous study [1], although the changes in the muscle damage markers were much smaller for KE than EF MaxEC. It is important that MVIC was effective for attenuating muscle damage induced by MaxEC, but further studies are necessary to investigate how MVIC produced the protective effect. **References** 1) Chen et al. (2012) *Med Sci Sports Sci*, 44, 2090-8.

### **REHABILITATION AFTER ACUTE HAMSTRING MUSCLE INJURIES AMONG ELITE SOCCER PLAYERS**

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**Introduction:** Hamstring muscles injuries among professional soccer players represent a heterogeneous group of damages as far as type, dimension or precise anatomic region. Therefore, these factors can create difficulties during decision-making related to rehabilitation recommendations and healing prognosis. Degree of repeated injuries in soccer is very high and frequently is correlated to inadequate rehabilitation program or early return to training and active playing. The aim of this study was comparison of two rehabilitation programs after acute hamstrings muscles injury among elite Kosovo soccer players, based on necessary time for players to return to training and active playing, and injury recurrence within the first year of returning to sports. **Methods:** Our prospective study was carried out at the Physical and Rehabilitation Medicine Clinic and at the Sports and Recreation Center in Prishtina, for the period of 12 months. Thirty three soccer players with acute hamstrings muscle injuries confirmed with Magnetic Resonance Imaging are divided into two rehabilitation groups. Seventeen players have undergone through muscular traction rehabilitation program (MT) and electrotherapy (ET), whereas the other sixteen players have received flexibility and strengthening exercise program (FSE). All injured subjects are clinically examined twenty four hours after injury, which includes manual flexibility evaluation and muscular strength of the affected and non-affected extremities. Treatment efficiency validation was measured through the necessary days required for safe return to training and active playing. **Results:** Subjects treated with MT and ET had earlier rehabilitation, average 24.6 days ( $ISD \pm 15$ , rank 10.1 – 43.9 days) compared to subjects of the second group treated with FSE rehabilitation program, their return to training and active playing occurred 49.5 days post rehab ( $ISD \pm 15$ , rank 13 – 87 days). Significant difference was acquired,  $p<0.05$ . After 1 year of return to sports, reinjury rate was significantly greater ( $P = .00251$ , Fisher's exact test) in the MT and ET group, where 9 of 17 athletes (52.9%) suffered a recurrent hamstring strain after completing the stretching and strengthening program, as compared to none of the 16 athletes (0%) in the FSE group. **Discussion:** We conclude that MT and ET rehabilitation program is more effective compare to FSE rehabilitation program after hamstring muscle injuries among Kosovar professional soccer players and their safe return to training and active playing. A rehabilitation program consisting of progressive agility and trunk stabilization exercises is effective in promoting return to sports and in preventing injury recurrence in athletes who have sustained an acute hamstring strain. (Shery & Best, 2004) Reference Sherry M, Best TM. A Comparison of 2 Rehabilitation Programs in the Treatment of Acute Hamstring Strains. (2004). *J Orthop Sports Phys Ther*;34:116-125.

### **CONCUSSION IN SCOTTISH MOTOR SPORT: AN INITIAL SURVEY OF AWARENESS AND PRACTICE**

Elliot, J., Richards, H., Turner, A.P.

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**INTRODUCTION** Guidelines about concussion in sport (McCrory et al. 2013) are not always known and used by practitioners and participants (White et al. 2014). Lateral and rotational forces that occur in motor sport present a risk of concussion and subsequent impairment of cognitive and physical performance could place competitors, spectators and officials at risk. Therefore, the aim of this study was to explore the occurrence, knowledge and awareness of symptoms, and management of concussion in Scottish motor sport. **METHODS** Scottish motor sport competitors ( $n=28$ ), officials ( $n=20$ ) and medical personnel ( $n=13$ ) completed an online survey regarding occurrence, knowledge and awareness of concussion. Mann-Whitney tests were used to compare groups' knowledge and symptom scores, estab-

lished using Likert scales. Where concussion had occurred participants were asked how it was managed, including open questions used to understand reasons for under-reporting. RESULTS Competitors (60.7%), officials (75%) and medics (100%) reported experiencing or observing concussion at least once at events. Medics reported significantly higher knowledge scores than officials ( $P=0.013$ ) and competitors ( $P=0.001$ ). There were no significant group differences in scores for recognition of concussion symptoms. Across all populations consistent knowledge-gaps included: lack of effectiveness of protective head-gear; longer recovery time required for younger people; and, increased risk of a second concussion. More competitors (75%), than officials (45% -  $P = 0.04$ ) and medics (39% -  $P = 0.013$ ) agreed that competitors could return to normal training/competition when symptom-free, in contrast to recommendations. 25% of competitors with concussion did not seek a medical review, for reasons including "not recognising concussion" and "wanted to race the next day". DISCUSSION This observational research highlights that concussion occurs in Scottish motor sport and that there is a lack of clear understanding about concussion and subsequent management in this environment. Areas of confusion are similar to reported in other sports (White et al 2014). Main areas to be addressed include education regarding staged return to training and competition (McCrory et al 2013) and dangers of competitors not reporting concussion and receiving medical attention. Research is needed to investigate the occurrence of concussion with a broader sample and using a range of methods, and to test the effectiveness of contrasting education strategies to raise awareness in practitioners and competitors (King et al 2014). REFERENCES McCrory P, Meeuwisse WH, Aubry M, et al. (2013) Br J Sports Med, 47, 250-258. White PE, Newton JD, Makdissi M et al. (2014) Br J Sports Med, 48, 119-124. King D, Brughelli M, Hume P, Gissane C (2014) Sports Med, 44(4), 449-71. CONTACT Jen1078@hotmail.com

## Oral presentations

### OP-PM51 Training & Testing: Coordination

#### LOWER EXTREMITY CONTROL IN RESPONSE TO 8-WEEK ACL-INJURY PREVENTION TRAINING IN FEMALE ADOLESCENT ATHLETES

Ullrich, B., Pelzer, T., Wöhlken, K., Hartmann, U., Holzinger, S., Pfeiffer, M.

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**Introduction** Female adolescent athletes who perform in sports with jump-landing movements suffer anterior cruciate ligament (ACL) injuries at a 4- to 6-fold higher rate compared with males (Hewett, 2000). Impaired lower extremity control is regarded as a key contributor of ACL injuries. More specifically, reduced knee flexion, increased hip adduction, and impaired hamstring activation during landing tasks might enhance the ACL injury risk (Hewett, 2000). Few studies examined the influence of ACL-prevention regimens on lower extremity control in female athletes. **Methods** Twenty-one elite adolescent female track and field athletes (13.9 years, 51.4 kg) participated in either an 8-week ACL-injury prevention program with two weekly sessions ( $n = 11$ ) using jump-landing and stability tasks, rope strengthening of the hip abductors, and Nordic Hamstring exercises or a control group ( $n = 10$ ). Two times before, and after the training period vertical ground reaction force (VGRF), lower extremity 2-dimensional sagittal and frontal plane kinematics and surface EMG activity from the vastus lateralis, medial hamstrings, gastrocnemius lateralis, and tibialis anterior were analysed in the dominant leg during the stance phase of bipedal drop jumping (DJ-dropping height: 40 cm) for both groups. Therefore, a zebris-force plate, SIMI-high-speed videography (100 Hz) and a Noraxon-EMG system were used. VGRF and kinematics were sampled in 10%-intervals of individual stance phase duration. EMG amplitude values (% Max.) of each muscle were divided into three equal sub-phases of DJ stance phase duration. A two-factor ANOVA (time \* groups) with repeated measures was used to analyze temporal changes and between-group effects. **Results** No significant temporal changes in any outcome occurred in controls. Post training, the DJ stance phase was significantly ( $P < 0.05$ ) reduced. Furthermore, hip flexion/extension patterns were significantly shifted in the extension direction and significant shifts towards more abducted hip joint positions occurred post training. However, knee joint sagittal and frontal plane kinematics and all EMG patterns remained constant during the study. **Discussion** Specific ACL-injury prevention training enhanced DJ performance and hip joint stability, but did not change knee joint kinematics and EMG landing patterns. Lower limb EMG landing patterns in well-trained adolescent athletes may show limited plasticity after short-term interventions. **References** Hewett, TE. (2000). Sports Medicine, 29 (5), 313-327.

#### COMPARISON BETWEEN THE STATIC BALANCE OF PRACTITIONERS FROM DIFFERENT SPORTS AND NON-ATHLETES

Gateva, M.I, Gospodarski, N.I, Treneva, V.I, Avramov, D.2, Ivanov, N.I, Andonov, K.I

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**Introduction** Compared to the vast number of publications concerning the balance in regards of the health aspect, balance as one of the main components of coordinative abilities has not been thoroughly investigated in the field of sport (Solan et al., 2007). Some sports require high level of balance to be developed. What is still interesting is what part of this ability is genetically determined and what depends on training and improvement. **Methods** 60 high level athletes from rowing, canoeing, rhythmic gymnastics, taekwondo and acrobatic gymnastics and 12 non-athletes were tested. All subjects were aged 13-14. Four tests, 30 seconds each, were performed on a force-platform: Test 1 – double leg stance with eyes open; Test 2 – double leg stance with eyes closed; Test 3 – single leg stance with eyes open and Test 4 – single leg stance with eyes closed. The parameters measured were average deviation of the centre of pressure (COP), the maximal deviation of COP and sway velocity. Descriptive statistics and ANOVA were used. **Results** The COP varied between 0,9 to 1,5 cm for Test 1 and Test 2. Significant differences between the groups and tests were not found. In test 3 values were between 1,3 to 2,8 cm deviation of COP and in test 4 values increase from 3,3 to 6,0 centimetres. **Results** from single leg stance with eyes open and eyes closed showed differences with the lowest results from the group of non-athletes and taekwondo and the best score of acrobat gymnast and kayakers. Maximal deviation of the COP showed significant difference in every test between the non-athletes (with lowest results) and all of the sport groups. Some differences between the sports were also observed. Better results were shown by the kayakers, rowers and rhythmic gymnasts compared to the acrobat and taekwondo athletes. The frequency analysis showed that rowers and kayakers (speed varied between 4,5 to 5,8 Hz) restore their balance quicker than the rest of the tested athletes and the non-athletes (0,7 to 2,4 Hz). **Discussion** We defined significantly greater difference in balance ability of the athletes aged 13-14 compared to the non-athlete children of the same age. An advantage in values was also detected in the athletes on small boats in the water, followed by the rhythmic gymnast, taekwondo athletes and acrobat gymnasts. Some studies (Hrysomallis, 2011; Bressel et al., 2007) also compared the level of balance of different sport competitors but found different results. **References** Bressel E, Yonker J, Kras J, Heath E. (2007). J of Athletic Training, 42(1),

42-46. Hrysomallis C. (2011). *Sports Med*, 41(3), 221-232. Solan H, Shelley-Tremblay J, Larson S. (2007). *Optometry and Vision Development*, 38 (1), 13 Contact maria.gateva@abv.bg

### THE EFFECT OF MENTAL TRAINING ON MOTOR PERFORMANCE OF TENNIS AND FIELD HOCKEY STROKES IN NOVICE PLAYERS

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**Introduction** Mental training techniques have been largely used by psychologists, coaches and athletes as a tool for improving learning and performance in sports (Hall & Fishburne, 2010). Forehand and backhand in tennis are the most common used in the field, similarly push pass and hit in field hockey. Therefore, the aim of this study was to examine the effects of mental training on learning ground strokes in tennis and field hockey. **Methods** 24 university students participated in the study. The experimental group received pre-test – mental training program – post-test. Students were taught tennis and field hockey strokes based on mental training, specifically relaxation, visualization and concentration-attention control. Measurements were conducted with the use of motor evaluation tests and questionnaires, once before the implementation of the program and once after the completion. **Results** Wilcoxon results revealed statistically significant differences between the initial and the final measurement for the performance ( $P=.004$ ) and the ability of concentration ( $P=.021$ ) for the forehand, backhand ( $P=.007$ ); ( $P=.033$ ) in tennis and push pass ( $P=.003$ ); ( $P=.008$ ) in field hockey. In addition a significant difference was found for the ability of concentration of the hit stroke ( $P=.005$ ) and similarly for the visualization in tennis and hockey ( $P=.003$ ); ( $P=.032$ ). However, no significant difference has been found regarding to the performance of the hit stroke. **Discussion** The results of the present study revealed that the use of mental training, combined with physical practice, contributes to the optimization of motor performance, which corroborates with the results found in previous studies (Jones & Stuth, 1997; Weinberg & Gould, 2014). Furthermore, researchers have shown that mental training is suitable for beginners as well as for performance optimization in intermediates and experts, also for children and youths for the optimization of precision and quality of movement (Immenroth et al., 2003; Mayer & Hermann, 2009). As a conclusion, a combination of mental and practical training promises the greatest improvement in performance and learning, because it involves all senses. **References** Hall, N., & Fishburne, G. (2010). *J Imagery Research in Sport and Physical Activity*, 5(1), 1-17. Immenroth, M., Haasis, M., Mayer, J., & Eberspächer, H. (2003). *Giessen: 35. Jahrestagung der Arbeitsgemeinschaft für Sportpsychologie*, 65. Jones, L., & Stuth, G. (1997). *Applied and Preventive Psychology*, 6, 101-115. Mayer, J., & Hermann, H.D. (2009). Heidelberg: Springer Medizin Verlag. Weinberg, R.S., & Gould, D. (2014). Champaign, IL: Human Kinetics, 5th Ed. Contact Khaled.Hegazy@partner.kit.edu

### GENDER AND PERFORMANCE LEVEL SPECIFIC DIFFERENCES IN BALANCE ABILITY OF ELITE AUSTRIAN ALPINE SKI RACERS

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**Introduction** The relationship between balance ability (BA) and injury risk has been established in many sports, but the relationship between BA and performance level is less clear (Hrysomallis, 2011). In alpine ski racing a high level of BA is fundamental. Consequently, tests analyzing BA of alpine ski racers are performed (Raschner et al., 2013). The aim of the study was to analyze gender and performance level specific differences in BA of elite Austrian ski racers. **Methods** 109 female ski racers (F-SR) [50 Junior team (F-JT), 30 European Cup (F-EC), 29 World Cup (F-WC)] and 115 male ski racers (M-SR) [55 Junior team (M-JT), 40 European Cup (M-EC), 20 World Cup (M-WC)] underwent two tests on the Biodex Stability System. The first test measured the athlete's ability to maintain postural stability (index) on the unstable tilting platform on one leg (oL-T). The objective of the second test, performed on both feet, was to move the cursor into nine blinking boxes as fast as possible (time in seconds), through tilting the platform (dL-T). Gender specific differences were calculated with the Welch-test. An ANOVA with Scheffe post-hoc-tests analyzed differences in BA between the performance levels of Junior, European Cup and World Cup teams. A criterion of  $p \leq 0.05$  defined significance. **Results** F-SR performed significantly better in oL-T Index [F-SR: 2.1 (95% CI: 2.0-2.6); M-SR: 3.2 (95% CI: 3.0-3.5)] and dL-T time [F-SR: 77s (95% CI: 75-79); M-SR: 88s (95% CI: 85-91)] compared to the M-SR. ANOVA indicated significant differences in oL-T and dL-T between female performance levels. Post-hoc-tests showed that both F-WC and M-WC as well as F-EC and M-EC performed significantly better than F-JT and M-JT. There were not any significant differences in BA between World Cup and European Cup teams in both genders. **Discussion** Ski racing requires perfect technical skills and a high level of physical fitness. Unexpected changes in terrain and high speeds challenge the athlete's balance; hence, it should be trained and tested. As expected, elite female athletes showed a better BA than elite male athletes. Furthermore, racing and training experience explain the enhanced BA of the F-SR and M-SR who were qualified for World and European Cup teams. An important aspect was analyzed by Noe et al. (2009), who showed that the mechanical effects of wearing ski-boots during balance tests of ski racers were compensated by changes in postural strategy through the reorganization of muscle coordination. **References** Hrysomallis C. (2011). *Sports Med*, 41, 221-232. Raschner C. et al. (2013). *Sport Orthop. Traumatol*, 29, 193-202. Noe F. et al. (2009). *J Electromyogr Kinesiol*, 19, 341-346. [Christian.Raschner@uibk.ac.at]

### BALANCE: SET OF SPECIFIC SKILLS OR GENERAL ABILITY?

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**Purpose:** Although there are many studies exploring the mechanisms of postural control and the adaptations in response to balance training, it is still under debate whether balance is a set of specific skills or a general ability, and consequently whether balance training leads to task-specific rather than general non-specific adaptations. To shed light on this issue, we devised the following experiment. **Methods:** Forty participants were assigned to one of two training groups or a control group. One training group completed six sessions on one balance training device, the other training group trained for the same time on a different balance training device. Before and after the training, they performed tests on both devices and had to perform two additional balance tasks on these devices but with a different direction of perturbation. **Results:** Analyses of variance showed that the training groups outperformed the other groups only in the task they had trained (significant group x time interaction effects,  $p < 0.001$ ). This means that there was no transfer even to very similar tasks. **Conclusions:** We conclude that training a balance task has mostly specific rather than general effects. Thus, we propose to view balance rather as a set of specific skills. Therefore, the selection of balance exercises should be executed with great care, regardless of whether

this is in studies exploring the underlying physiological mechanisms of postural control or balance adaptations, in studies quantifying the effects of balance training or when issuing recommendations for rehabilitation or fall prevention training regimens.

#### APPLICATION OF HYPOXIC TRAINING IN TECHNICAL SPORTS.

Zelenkova, I.I, Zotkin, S.I, Korneev, P.I, Koprov, S.I, Almiyashev, D.I, Grushin, A.I

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Currently altitude/hypoxic training is used by elite endurance athletes in summer and winter sports in year-round training plan. Nevertheless there is not widespread use of altitude/hypoxic training in technical sports which is also demanding in multifaceted cognitive and physical abilities. The main characteristic of professional drivers is the reaction time. Also fatigue related crashes due to safety errors are common in professional drivers, furthermore if the competition are carried out in altitude the reaction time is slowing down in a dose-dependent manner. The aim of the present study was to investigate the influence of altitude/hypoxic training in cognitive and physical abilities of professional truck drivers. Twelve male athletes (177 (175.7-182)cm, 82.4 (75.4-85.6)kg, body mass index 25.4 (24.6-26.78)kg/m<sup>2</sup>, 32.5(29-39.5) years) members of the Russian truck team participated in the study. Before and after the hypoxic program each subject underwent body mass composition analysis (InBody), determination of total hemoglobin mass (tHb-mass) using optimized CO-rebreathing method (Bloodtec spirometer, ABL80 FLEX CO-OX analyzer), hemoglobin (Hb) and ferritin (Fe) concentration (from capillary blood, BTS-350). Incremental test for anaerobic threshold determination (Biosen C-Line lactate analyzer) on a stationary cycle ergometer (Ergoselect 200) in hypoxic (at 4000 m; Hypoxico Everest Summit II) and normoxic conditions with the determination of reaction time (Fitflight trainer) were performed. During 21 days each subject participated in "Live high – train low and high" hypoxic program. For rating sample characteristics, median and interquartile dispersion was used. Non-parametric Wilcoxon tests were applied for referencing bound samples. Significance level P was rated at 0.05. Prior the program the significant decrease in visual reaction time in hypoxia 12,7% was found in drivers (P<0.01) and 23,5% decrease in power output on anaerobic threshold (P<0.01) comparing with normoxia. After the program a significant increase in muscle mass weight (P<0.01), decrease in fat weight (P<0.01), significant decrease in time of reaction in hypoxic (P<0.01) and normoxic (P<0.05) condition and increase in power output in incremental test in hypoxic (P<0.01) and normoxic (P<0.01) were found. The difference in time of visual reaction between hypoxia and normoxia after the program was 2,1% and wasn't significant. There was no significant difference in absolute values of tHb-mass, blood volume and Hb concentration but there was significant increase in reliable tHb-mass (P<0.01) and blood volume (P<0.05). The increase of visual-motor response in technical sports can provide the "competitive edge" to succeed at high level events, mostly, if competitions are carried out at altitude and probably decrease fatigue related safety errors.

## Oral presentations

### OP-BN06 Muscle function

#### FREQUENCY OF REGULAR EXERCISE AFFECTS THE TIME UNTIL CHANGE IN MUSCLE VISCOELASTICITY DURING STATIC STRETCHING

Okamura, N., Tsukune, M., Kobayashi, Y., Fujie, M.G.

*Waseda University*

**INTRODUCTION** Static stretching is used to decrease muscle tone. However, the optimal length of time to hold a stretch is unclear, since continuous measurement of muscle tone during static stretching is difficult. We previously described a new method for evaluating muscle tone using a spring-pot viscoelastic model, and demonstrated a change in viscoelastic ratio during 1 min of static stretching (1). In this study, we used this method to investigate the time required to change muscle viscoelasticity in people with different exercise habits. **METHODS** Nine healthy university students aged 20-22 yr (8 males, 1 female) participated in this study. Participants were divided into three groups (n = 3/group) based on their regular exercise frequency: (A) more than once per week, (B) more than once per month, and (C) less than once per month. To measure muscle viscoelasticity, a semispherical indenter tip including a force sensor was fixed to the skin over the center of rectus femoris with an inextensible band. Each subject did 1 min of static stretching using arbitrary strength and we measured the reaction force at the indenter. Using this method, the viscoelastic ratio appears as the slope of the reaction force model. We calculated the time until change in viscoelasticity by plotting slope versus time during static stretching. **RESULTS** On the slope versus time graph, there was a negative peak when the muscle viscoelasticity changed and a positive peak when the subject bent their leg to begin stretching. We calculated the time between the two peaks, and the mean values and standard errors of the time until change in viscoelasticity were (A) 23 ± 2.5 sec, (B) 25 ± 1.8 sec, (C) 34 ± 2.1 sec. **DISCUSSION** The time required to change muscle viscoelasticity by static stretching tended to increase with a decrease in the frequency of regular exercise. When muscle is stretched for a prolonged period, stretch receptors react and cause Ib inhibition that allows muscle tone to decrease (2). More frequent exercise may enhance stretch receptor sensitivity and affect the time needed to change muscle viscoelasticity. When measurements were taken from the opposite leg of the same person, the intraindividual standard deviation of most subjects was less than that of each group. This suggests that muscles in similar condition such as fatigue degree need similar amounts of time to be affected by static stretching. Therefore, the time spent stretching should be changed as muscle condition changes. Future studies will investigate the effects of intraindividual changes in exercise habit and difference in target muscles. **REFERENCES** (1) Okamura, N. et al. (2014). Conf Proc IEEE Eng Med Biol Soc. 6919-6922. (2) Suzuki, S. (2013). Science of Stretching. Miwa-Shoten Ltd. Japan. CONTACT n-okamura@toki.waseda.jp

#### ACUTE EFFECTS OF MUSCLE LENGTH DURING THE CONTRACTION PHASE OF CONTRACT-RELAX STRETCHING ON MUSCLE-TENDON MECHANICS

Kay, A.I, Dods, S.I, Blazeovich, A.2

1: *UoN (Northampton, UK), 2: ECU (Perth, Australia)*

**Introduction:** Proprioceptive neuromuscular facilitation (PNF) stretching frequently results in the greatest increases in range of motion (ROM), with contract-relax (CR) being a common variant of the PNF technique. However, despite its efficacy to increase ROM, the underlying mechanisms are poorly understood; furthermore the contractions performed in a highly stretched position during CR stretching can

be painful and induce muscle tissue damage, thus its use is somewhat limited in athletic environments. Therefore, the acute effects of CR stretching and a modified CR (MCR) stretching technique (with the contraction phase performed 'off stretch') were studied in 14 healthy human volunteers. Methods: Passive ankle joint moment and dorsiflexion ROM were recorded on an isokinetic dynamometer with electromyographic (EMG) monitoring of the triceps surae, whilst simultaneous real-time motion analysis and ultrasound imaging recorded gastrocnemius medialis muscle and Achilles tendon elongation. The subjects then performed either CR (4 x 10 s stretches + 5 s contractions) or MCR stretches randomly on separate days before reassessment. Results: Significant increases in dorsiflexion ROM (4.0-4.1°;  $P < 0.01$ ) and decreases in the slope of the passive moment curve (13.3-19.1%;  $P < 0.01$ ), muscle stiffness (21.3-21.7%;  $P < 0.01$ ) and tendon stiffness (15.7-20.4%;  $P < 0.01$ ) were observed in both conditions. A significant increase in peak passive moment (stretch tolerance) occurred after MCR (8.8%;  $P < 0.05$ ) with a similar mean increase after CR (8.9%;  $P = 0.053$ ); significant correlations ( $r = 0.70-0.75$ ;  $P < 0.01$ ) were observed between the changes in peak passive moment and ROM. No differences in between-condition changes were found in any measure ( $P > 0.05$ ). Conclusion: Similar mechanical and neurological changes were observed between conditions, indicating that identical mechanisms explain the analogous ROM improvements, regardless of muscle length during the contraction phase. Importantly, performing the contractions 'off stretch' removes the need for partner assistance, and reduces the potential for microtrauma, likely minimising the risk of inducing muscle strain injury. Thus, the modified CR stretching technique represents an equally effective, simpler, and yet potentially safer, stretching paradigm. Contact: tony.kay@northampton.ac.uk

### COMPUTED PASSIVE TENSILE TEST TO FAILURE OF THE MUSCLE-TENDON COMPLEXE USING A DISCRETE ELEMENT MODEL

Roux, A., Lecompte, J., Iordanoff, I., Laporte, S.

*Arts et Metiers ParisTech*

**Introduction** Muscle tears are common sports-related injuries, the majority of which occur whilst eccentric exercises when muscle contraction is combined with excessive stretching (Uchiyama et al., 2011, Pétillon et al., 2005). A clear understanding of the mechanical conditions that cause the muscle-tendon complex (MTC) to fail as well as structures involved are required to prevent the risk of tear and/or improve rehabilitation specificity (Uchiyama et al., 2011). New numerical approach using discrete element method (DEM) could be the most appropriated to take the architecture and the complex behavior of MTC into account. The aim of this study was therefore to first model and then investigate mechanical elongation response of MTC until rupture. Methods Numerical model was complete in DEM using GranOO software ([www.granoo.org](http://www.granoo.org)). Mechanical properties of MTC were based on literature values (Matschke et al., 2013, Regev et al., 2011). Fibers were built with spherical discrete elements linked with springs (stiffness was related to elastic modulus (EM) (EM=37.44 kPa). The extracellular matrix was computed using springs between fibers. Tendon's fibers were built with respect to muscle fibers architecture (EM=800 MPa). The myotendinous junction (MTJ) was represented by multi-links between tendon and muscle. MTC stress-strain relationship was fitted during a computed tensile test. MTC was fixed on its lower extremity and the upper extremity was subjected to a linear displacement. Elongation was chosen as rupture's criterion, i.e. when spring's lengths overreach 30% of strain (Noonan et al., 1994). Results and Discussion The computed stress-strain relationships display a classical hyper-elastic shape in agreement with in vitro experimental data of Gras et al. (2012). The use of linear springs, added to the MTC's structural effect, leads to a hyper-elastic behavior for the MTC's response in tensile test. Values of mechanical properties of extracellular matrix (EM=100 kPa) and MTJ (EM=400MPa) had to be adjusted in order to fit with experimental data due to the lack of data in the literature. As attending, rupture appeared at the MTJ (Pétillon et al., 2005). MTJ was at the interface between the stiff tendon and the soft muscle, leading to a stress concentration. MTC was broken by fibers' delamination, in agreement with in vitro data (Ilaslan et al., 2007). Conclusion DEM seems to be a promising method to model the hyper-elastic macroscopic response of MTC and investigate the rupture. In order to model MTC's tear, muscle's contraction will be implemented. References Gras et al. (2012). *J Mech Behav Biomed Mater* 15,131-140 Ilaslan et al. (2007). *Skeletal Radiol* 36(6), 503-507 Matschke et al. (2013). *Sci World J* 514743 Noonan et al. (1994). *Am J Sports Med* 22,257-261 Pétillon et al. (2005). *Oper Tech Sports Med* 13,162-168 Regev et al. (2011). *Spine* 36, 1666-1674 Uchiyama et al. (2011). *Sports Med Arthrosc Rehabil Ther Technol* 3, 20 Contact anthony.roux@ensam.eu

### LATERALITY OF THE MORPHOLOGICAL PROPERTIES OF THE VASTUS LATERALIS MUSCLE IN NON-UNILATERAL SPORT ACTIVITIES

Marzilger, R.1, Bohm, S.1, Schroll, A.1, Legerlotz, K.1, Arampatzis, A.1

*1: HU (Berlin, Germany)*

**Introduction** Vastus lateralis (VL) morphological properties like muscle fascicle length (FL) and cross-sectional area (CSA) have been shown to differ between athletes and non-active persons (Kearns et al., 2000; Abe et al., 2000). In unilateral sport events (e.g. soccer) a leg specific hypertrophy has been reported (Kearns et al. 2001) resulting in an asymmetric morphology between dominant (DL) and non-dominant leg (NDL). Most studies investigating morphological muscle properties focused only on one leg, assuming muscle symmetry between both legs. Therefore the purpose of the present study was to compare the morphological properties (i.e. FL and CSA) of the VL muscle between the DL and NDL of persons involved in non-unilateral sports (2-5h sport/week). Methods The FL and the CSA of the VL muscle of both legs were measured in 18 participants. To determine the VL FL, the participants were seated in a dynamometer (Biodex) and their knee joint was passively moved from 0°-100° with 10°/s while the FL was captured with a 10cm ultrasound probe (Esaote) at the mid portion of the muscle belly. The VL FL was calculated from the captured ultrasound videos with a self-developed semi-automated tracking algorithm. To determine the VL CSA, magnetic resonance images (Turbo 3D T1, TE=16ms, TR=39ms, slice thickness 3.1mm, no gaps between slices) of the thigh were obtained and the transversal pictures were then manually analyzed in Osirix (Pixmeo SARL). For statistical analysis the maximum CSA of both legs was evaluated and the FL of DL and NDL was compared every 5° from 20° to 80° of knee joint angle. Results The average CSA of the DL and NDL were 32.7±4.0cm<sup>2</sup> and 32.5±4.6cm<sup>2</sup> respectively. The average fascicle length ranged from 101.9±13.1mm (20° knee joint angle) to 131.2±16.0mm (80°) in the DL and from 103.8±12.2mm (20°) to 134.6±14.5mm (80°) in the NDL. There were no statistically significant differences between the DL and NDL, neither in FL nor in CSA. Discussion The results show that in moderately active persons that are not involved in unilateral sports, the FL and the CSA of the VL do not differ between the DL and NDL. These findings indicate that moderate non-unilateral sports activities do not lead to side asymmetries in morphological properties of the VL. We conclude that the examination of the VL muscle from one leg would be enough in cross-sectional studies investigating the morphological properties of the VL between groups without specific unilateral mechanical loading. References Abe T, Kumagai K, Brechue WF. (2000). *Med Sci Sports Exerc*, 32, 1125-1129. Kearns CF, Abe T, Brechue WF. (2000). *Eur J Appl Physiol*, 83, 289-296. Kearns CF, Isokawa M, Abe T. (2001). *Eur J Appl Physiol*, 85, 240-243. Contact robert.marzilger@hu-berlin.de

**DIFFERENTIAL TENDINOUS TISSUE ADAPTATIONS AFTER CONVENTIONAL VS. EXPLOSIVE STRENGTH TRAINING**

Massey, G.J.1,2, Balshaw, T.G.1,2, Maden-Wilkinson, T.M.2, Tillin, N.A.3, Folland, J.P.1,2

1: Arthritis Research UK, Centre for Sport, Exercise and Osteoarthritis, 2: Loughborough University, UK, 3: University of Roehampton, UK

**Introduction** Conventional strength training, with an emphasis on sustained high loads, increases muscle tendinous-tissue (aponeurosis and tendon) unit (MTU) stiffness, with some evidence for modest tendon hypertrophy. Explosive training, with an emphasis on rapid force development, may elicit similar changes in MTU mechanical stiffness in a substantially shorter period of time (Tillin et al., 2012). However the efficacy of explosive training to elicit tissue adaptation requires a direct, detailed comparison. This study aimed to assess the mechanical adaptations of the MTU (stiffness) and patellar tendon (stiffness, young's modulus) to conventional and explosive strength training, as well as the changes in tendon cross-sectional area and thus hypertrophy. **Methods** Following familiarisation, young healthy untrained males were matched for maximal voluntary force (MVF) and randomised to 12 wks (3 x per wk, 4 sets, 10 reps) of either maximal (MST, n =10: 1 rep = 1-s up to ~75% MVF, hold ~3-s, rest 2-s) or explosive (EXP, n = 11: 1 rep = fast and hard [>80% MVF] ~1s, rest 5-s) isometric knee extension strength training. Simultaneous force and ultrasound recordings of both vastus lateralis aponeurosis and patellar tendon elongation during constant loading-rate ramp contractions were used to derive MTU and PT stiffness respectively, at a common tendon force level. Mean tendon cross-sectional area was measured from magnetic resonance images (Pre and Post). Tendon stress was calculated and young's modulus estimated over a common stress range. Time [pre-post] x group [MST-EXP] interaction effects were assessed with two-way ANOVA. Results MTU stiffness increased after MST (pre 561 ± 101 vs. post 732 ± 217 N.mm; +30.9%, P = 0.014), but not after EXP (pre 579 ± 105 vs. post 588 ± 86 N.mm; +4%, P = 0.772), resulting in an interaction effect (ANOVA, P=0.02). After both types of training PT stiffness (MST, +22.1%, EXP +20.5%; ANOVA, P=0.888) and young's modulus (MST, +14.5%, EXP, +20.5%; ANOVA, P=0.359) increased similarly. No tendon hypertrophy was observed in either group. **Discussion** Our data indicate that conventional strength training induced a more pronounced increase in MTU stiffness than explosive training. In contrast both interventions elicited equivalent increases in tendon stiffness and young's modulus. These results suggest a differential adaptive response of the tissue components within the MTU (muscle-aponeurosis vs tendon) according to the strength training regime. **References** Tillin NA, Pain MTG, Folland JP. (2012). *Exp Physiol*, 97.5, 630-641. Contact G.Massey@lboro.ac.uk

**Oral presentations****OP-SH20 Philosophy & Ethics II****HUMAN PRACTISING - TOWARDS AN ASCETOLOGICAL UNDERSTANDING OF SPORT**

Aggerholm, K.

*University of Southern Denmark*

Within the philosophy of sport the phenomenon of practicing (asceticism) has received very little attention, whereas other related aspects of sport such as excellence (aretism) and competition (agonism) have been subjected to many and thorough studies. Departing from my own studies on talent development in sport (Aggerholm, 2015) and drawing on anthropological and philosophical accounts of practising (Foucault, 2005; Sloterdijk, 2009), I will attempt to clarify this particular phenomenon and interrogate the potential relevance of it for the sport sciences by highlighting central aspects such as repetition, verticality and effort. I will in particular use it to challenge existing accounts of sport within the philosophy of sport, e.g. formalism, conventionalism and internalism, to suggest that human practising can inform a supplemental ascetological account of sport. **References:** Aggerholm, K. 2015. *Talent Development, Existential Philosophy and Sport: On Becoming an Elite Athlete*. Abingdon: Routledge. Foucault, M. 2005. *The Hermeneutics of the Subject. Lectures at the Collège de France 1981-1982*. Translated by G. Burchell. Edited by F. Gros. New York: Palgrave Macmillan. Sloterdijk, P. 2009. *Du mußt dein Leben ändern*. Berlin: Suhrkamp.

**THE AESTHETIC EXPERIENCE IN THE COMBAT SPORTS: A STUDY IN TAEKWONDO**

Coelho, R.C.1, Kreft, L.2, Lacerda, T.3

1: CEFET/RJ (Rio de Janeiro, Brasil), 2: UNI-LJ (Ljubljana, Slovenia), 3: FADEUP (Porto, Portugal)

**Introduction** The investigation on sport's aesthetic experience is still limited, especially regarding the athlete's point of view. The aim of this study was to understand the aesthetic experience lived by senior athletes from Taekwondo Portuguese National Team, in poomsae and combat practice, focusing on reveal the elements which may contribute to the enlargement of the knowledge in this domain. This study started from the literature on general aesthetic, sport aesthetic, and Taekwondo, considering the peculiarities and personal experience of the object. **Methods** The research of qualitative nature, with a phenomenological approach, had an exploratory and a descriptive character. The speech of twenty- two athletes was collected in semi-structured interviews. The information was treated through content analysis of the athletes' speech. **Results** For the poomsae athletes was manifest that the elements, technique, tactical/game, affection/taste, aggressiveness, transcendence/overcoming and kihap (yell), are significant to an understanding of the aesthetic experience of these individuals. In relation to the combat athletes was observed that the elements, technical, tactical/game, affection/taste, aggressiveness, risk, transcendence/overcoming, victory and kihap, were found to be the most significant for the understanding of aesthetic experience in this context. **Discussion** From the analysis and interpretation of this information, it was concluded that the athlete of Taekwondo, in search for the perfect techniques and tactics execution, with the constant support of his/her fellows, adopting an aggressive/assertive posture, surpassing risky situations, and in some moments externalizing his/her inner energy through kihap, overcoming limits, winning, is able to live harmonious, beautiful, ludic, affective experiences, that is, aesthetic experiences. **References** Iseminger, G. (2003). *Aesthetic Experience*. In Levinson, J. (2003). *The Oxford Handbook of Aesthetics*. Oxford: University Press, 99-116. Kant, I. (2010). *Crítica da Faculdade do Juízo*. Rio de Janeiro: Forense Universitária. Kreft, L. (2012). Sport as a drama. *Journal of the Philosophy of Sport*, Champaing, 39(2), 219-234. Lacerda, T. de O. (2004). *Acerca da natureza da experiência estética desencadeada pelo encontro com o Desporto e do seu contributo para a educação estética do ser humano*. In Lebre, E. & Bento, J. (Ed.). *Professor de Educação Física: officios da profissão*. Porto: FCDEF-UP, 301-307. Matravers, D. (2003). *The aesthetic experience*. *British Journal of Aesthetics*, 43(2), 158-174. Schiller, F. (1991). *Cartas sobre a educação estética da humanidade*. São Paulo: EPU. **Funding** The primary author was supported by Foundation for Science and Technology, Portugal (FCT). Contact rebecacoelho@hotmail.com



## USING TRADITIONAL GAMES TO PROMOTE SUSTAINABILITY & PEACE IN THE ARCTIC

Killbourne, J.

*Grand Valley State University*

With climate change expanding trade routes in the Arctic and the resultant pursuit of oil, gas, mineral deposits, and fish, it is imperative that the eight Arctic countries find paths towards sustainability and peace in the region. Revisiting and understanding the traditional games of the indigenous people of these regions can go a long way towards helping those determining the region's future to work cooperatively towards these goals. Throughout history the games we have played have been a testament about who we were, and are. From early Inuit bone and hunting games, to the gladiator contests of Ancient Rome, to the modern American game of baseball, the games we play have served as a statement of and a rehearsal for the life-world of that period and place. By reconnecting with and understanding the games of our past, we can build meaningful bridges between our past and present, and hopefully gain a better understanding of our modern world. The aforesaid are timely and important, especially as they relate to indigenous people throughout the world who are trying to preserve their traditions in a fast changing modern world. Israel Ruong (1953) called the preservation of indigenous Sámi traditions, "active adaptation." He said, "Active adaptation means that Sámi cannot alone and without criticism adopt modern culture, casting aside their culture's irreplaceable values, but that they hold fast to their cultural traditions in the new conditions (Ruong cited in Lehtola, 2004: p. 60). This presentation/paper will be divided into two parts. The first part will provide a discussion on the importance of play and games. Section two will offer, based on my research and experiences in the Arctic, lessons learned from traditional Arctic games that may help promote sustainability and peace in the Arctic world. Hopefully by acknowledging these lessons we can pursue a path forward, together reconnecting with the traditional games of the Arctic with the hope of building meaningful bridges between the past and present and moreover, helping to enhance our understanding of the important role traditional games can play in shaping an Arctic where sustainability and peace flourish. Lehtola, V. (2004). *The Sámi people*. Fairbanks, Alaska: University of Alaska Press.

## A STUDY OF "UNIVERSAL SPORTS": THROUGH THE PHENOMENOLOGICAL PERSPECTIVE IN RELATION TO VARIETIES OF HUMAN BODIES

Tanaka, A.

*Musashi University*

Introduction It is essential for modern sports to be competitive to ensure improvements in the skills and training practices of athletes. If competition escalates further, however, there will be problems such as violence, doping and the forced manipulation of persons (Eichberg H (2010)). In addition, weaker players tend to be excluded from sports competitions by the 'win at all costs'. To enable a greater number of people to become attracted to sports and grasp its essence, it is necessary to consider and embody the idea of "universal sports" so that more people can be included. Therefore, the purpose of this presentation is to examine and clarify the concept of "universal sports" through the phenomenological perspective in relation to varieties of human bodies. Procedure of consideration I use the term "Universal sports" to mean inclusive sports related to the diversity of player's bodies. It refers to the opportunity for people with physical strength or potential as well as people with limited physical strength or advanced age to participate. In competitive sports for disabled people, issues of categorization are considered to be significant (Francis, 2005). From an educational viewpoint especially in Japan, simple and easy games are often proposed as teaching materials at school. However, "universal sports" are not typically realized from those games because such activities generally lack interest, a sense of achievement, and growth. Players would find it difficult to enjoy such games. Thus, it would be helpful to define "universal sports", which requires the following discussions: 1) What are the barriers to embodying the idea of "universal sports"? 2) What are the varieties of human body? 3) Are there ways to achieve universality? Discussion Based on the examination of the above questions, the idea of universality can be clarified by some inclusive sports cases. For example, sitting volleyball enables the disabled and the healthy to participate together (Tanaka, 2010). The conclusion is as follows: although the idea of universal sports is to relativize the physical gap in sports abilities of people, it must also promote personal growth through improving movement skills and engaging in appropriate training. It should contain new type of movements and pliable rules so that anyone can change aspects of his/her body by practicing sports movements. References Eichberg H (2010) *Bodily Democracy: Towards a Philosophy of Sports for All*, Routledge, London & New York Francis L (2005) *Competitive Sports, Disability, and Problems of Justice in Sports*, *Journal of the Philosophy of Sport*, 2005, 32, 127-132. Tanaka A (2010) *A Research on Practice of Sports to be Tolerant to differences (2) - "Inclusion in Playing Sports"*, *The Journal of Human and Cultural Sciences* 41(3,4), 410-422

## BASKETBALL WAS INTRODUCED TO JAPAN AT FIRST AS A SPORT FOR WOMEN RATHER THAN FOR MEN

Kakiyama, T.

*Fukuoka University*

Introduction In Japan, the first person who introduced the basketball to Japan is generally believed to be Mr. Hyozo Omori, who graduated from the International YMCA Training School in 1908 and went on to become Sports Director at Tokyo YMCA. This commonly accepted view has also been adopted by the International Basketball Federation (FIBA). However, in a photograph taken in 1902 in the outdoor playing field at Nagasaki Kwassui girl's school, I found a basketball goal behind the schoolgirls who were practicing a new style of gymnastics. The purpose of this study is to determine whether or not basketball had been played in Nagasaki Kwassui girl's school before Mr. Hyozo Omori introduced the sport for the first time in 1908. Methods I visited Springfield College (The birthplace of basketball) to identify the basketball goal of Nagasaki Kwassui girl's school, and extracted a description about the revisions rules for the basketball goal by tracing Amateur Athletic Union (AAU) Official Basket Ball Rules housed at the Archives Center, Springfield College. Results Ms. Mariana Young introduced American-style physical education at Nagasaki Kwassui girl's School. They used wooden circles, sticks and dumbbells, and every word of command was spoken in English in tune with the music by training Japanese women as physical education instructors. In the meantime, looking specifically at the revisions of the rules for the basketball goal by tracing AAU Official Basket Ball Rules housed at the Archives Center, Springfield College, the birthplace of basketball, all they had in the year 1895-96 was the basket, and then in the year 1896-97 and after, a wire mesh called a SCREEN was placed behind each basket as was also shown in the court plan. It was also revealed that the currently used flat-board-style backboard was first adopted in the 1904-05 rules. By magnifying and observing the picture of a basketball goal installed at the outdoor playing field of Nagasaki Kwassui girl's school, it was confirmed that wire mesh was fitted onto a wooden frame. Thus, the basketball goal of Nagasaki Kwassui girl's school that had been photographed in 1902 was identified as a SCREEN before the backboard was adopted. Discussion The possibility has been suggested that basketball was

introduced by Ms. Young at Nagasaki Kwassui girl's school before the time when, according to the accepted view, Mr. Hyozo Omori was said to have introduced the sport to Japan for the first time (i.e. 1908), and hence it seemed likely that basketball was introduced to Japan at first as a sport for women rather than for men. Contact [kakiyama@fukuoka-u.ac.jp](mailto:kakiyama@fukuoka-u.ac.jp)

# Saturday, June 27th, 2015

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**08:30 - 10:00**

## Oral presentations

### OP-PM32 Sports Medicine & Orthopedics: Physiotherapy III

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#### **COMPARISON OF COLD COMPRESSION THERAPY WITH OTHER RECOVERY METHODS IN ELITE JUNIOR CYCLIST IN HEAT**

Chan, Y.

*Hong Kong Sports Institute*

**INTRODUCTION** Cryotherapy is one of the recovery methods commonly used after sporting events. Cold water immersion (CWI) is a common and effective form of cryotherapy, by inducing vasoconstriction, stimulate venous return, aid metabolite removal after exercise, reduce swelling and muscle soreness (Bleakley et al., 2010; Vaile et al., 2008; Vaile et al., 2011). However, CWI may not be possible without large amount of ice and pool. Cold compression therapy (CCT) can be simply implemented by applying a cold compression wrap on an injury or major exercised muscles. Little scientific evidence exists yet to proof its effectiveness. **METHODS** Eight elite male junior cyclist (mean age 15.5, height 167.7cm, body mass 57.3kg, peak oxygen uptake 64.7ml/kg/min) completed a maximal cycling test to determine their peak power output (PPO) and oxygen uptake. Subjects then completed 3 tests on separated days with randomized recovery strategies of CWI, CCT and active recovery (ACT) for 15 mins at 31.4C and 74% relative humidity. Each test consists of two 35-min exercise bouts. Each exercise bout included 5 mins warm up, followed by 15 minutes 75% PPO and 15 mins maximal effort time trial. There was 55 mins rest between two exercise bouts, which included 5-min active cool down, 10-min treatment preparation, 15-min randomized recovery strategy and 30-min passive recovery in heat. **RESULTS** No significant differences were observed between average power output, blood lactate, rating of perceived exertion and heart rate for all recovery strategies. However, core temperature decreased significantly before the start of the second exercise bout for CWI. The core temperature also coincides with the mean thermal sensation scale, ranges from 0 (unbearably cold) to 8 (unbearably hot), during recovery strategies for CWI, CCT and ACT (2.64, 3.25 and 4.31 respectively). **DISCUSSION** The current findings suggest that all CCT, CWI, ACT are useful recovery strategies to allow athletes preparing for the next training bouts. CWI may cause thermal discomfort and lower the core temperature to below pre-exercise values; active recovery causes progressive glycogen in muscle fibers (Stamford et al., 1981); while CCT needs special equipment. To find the best recovery strategy, athletes' preferences, duration of exercise, facilities available and rest duration should all be taken into account. **REFERENCES** Bleakley CM, Davison GW. (2010). *Brit J Sport Med* 44(3):179-187. Stamford BA, Weltman A, Moffatt R, Sady S. (1981). *J Appl Physiol* 51(4), 840-844. Vaile J, Halson S, Gill N, Dawson B (2008). *J Sport Sci*, 26(5), 431-440. Vaile J, O'Hagan C, Stefanovic B, Walker M, Gill N, Askew CD. (2011). *Brit J Sport Med*, 45(10), 825-829. **CONTACT** Chan, YY (cy@hksi.org.hk)

#### **INCREASED PAIN PRESSURE THRESHOLD FOLLOWING ROLLING MASSAGE MAY BE, IN PART, DUE TO CENTRAL NERVOUS SYSTEM MODULATION OF PERCEIVED PAIN.**

Behm, D.

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Self-massage using roller massagers are often used to promote soft-tissue extensibility and optimal muscle functioning, subsequently reducing pain. However, the underlying mechanisms for pain reduction following self-massage is not fully understood. The aim of the present study was to quantify and compare the acute effect of rolling massage and manual deep tissue massage on pressure pain threshold (PPT) in individuals with tender spots in their plantar flexor muscles. In a randomized control trial study, tender spots were identified in 150 participants' plantar flexor muscles (gastrocnemius or soleus). Then participants were randomly assigned to one of five intervention groups (n = 30): 1) heavy rolling massage on the calf that exhibited the higher tenderness (Ipsi-R), 2) heavy rolling massage on the contralateral calf (Con-R), 3) light stroking of the skin with roller massager on the calf that exhibited the higher tenderness (SHAM), 4) manual massage on the calf that exhibited the higher tenderness (Ipsi-M) and 5) no intervention (Control). PPT was measured 30s (75 participants) and 15 minutes post-intervention (75 participants) via a pressure algometer. At 30s post-intervention, the Ipsi-R (24%, p=0.006) and Con-R (21%, p=0.02) demonstrated higher PPT values compared with Control and SHAM while Ipsi-M showed higher values than SHAM (31.27%, p<0.001). At 15 minutes post-intervention, PPT was higher following Ipsi-R (19.2%, p<0.001), Con-R (15.9%, p=0.002) and Ipsi-M (10.9%, p=0.05) compared with Control. With all groups combined, PPT declined at 15 minutes post-intervention compared to 30s post-intervention (12.3%, p=0.03). There was no difference between the effects of three deep tissue massages (Ipsi-R, Ipsi-M and Con-R) on PPT. Whereas the increased PPT following ipsilateral massage (Ipsi-R and Ipsi-M) may be attributed to the release of fibrous adhesions; the non-localized effect of rolling massage on the contralateral limb suggests that other mechanisms such as a central pain-modulatory system play a role in mediation of perceived pain following brief tissue massage.

#### **EFFECTS OF HALLIWICK TECHNIQUE ON PHYSICAL FITNESS OF CHILDREN WITH SPASTIC CEREBRAL PALSY IN SCHOOL AGE**

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**Purpose:** To discuss the hydrokinesitherapy for the school-aged cerebral palsy and explore the suitable hydrokinesitherapy method for school-aged children with cerebral palsy by observing the effect of Halliwick technique on physical fitness. **Method:** Twenty-four spastic cerebral palsy children of Guangzhou Cerebral Palsy Rehabilitation School were selected as subjects. These subjects were divided into

the control group (regular rehabilitation therapy, n=12) and the experimental group (regular rehabilitation plus swimming training, n=12). The physical fitness of the subjects was assessed before and after the treatment. Results: Half of experiment group can swimming 50-100m independently after 4 months training. Lung's capacity, sit and reach of swimming group were significant higher after treatment than before ( $P < 0.05$ ). The control group's were no significant difference at the same time ( $P > 0.05$ ). There was no significant difference of BMI, sit and reach between two groups after treatment ( $P > 0.05$ ), except lung's capacity of swimming group was significant higher than the control group ( $P < 0.05$ ). Conclusion: Halliwick technical is an effective method to guide swimming training for school-aged children with cerebral palsy. Swimming can effectively enhance the flexibility and respiratory capacity and it could be an effective method for school-aged children with cerebral palsy to achieve life-long sport and rehabilitation. Keywords: Hydrokinesitherapy; Halliwick technique; Spastic cerebral palsy; Physical fitness

#### EFFECTS OF CONVENTIONAL RESISTANCE TRAINING AND RESISTANCE TRAINING WITH INSTABILITY ON PHYSIOLOGICAL RESPONSES TO MAXIMAL CARDIOPULMONARY EXERCISE TEST IN PATIENTS WITH PARKINSON'S DISEASE

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Introduction: Parkinson's Disease (PD) is a neurological disease characterized by motor disturbances and cardiovascular autonomic regulation impairments. Conventional resistance training (CRT) and resistance training with instability (RTI) improve motor functions in this population. However, their effects on cardiovascular system are unclear. Thus, this study evaluated the effects of these training regimes on physiological responses to a maximal cardiopulmonary exercise test in patients with PD. Methods: Thirty eight patients with PD (Hoen & Yarh stages II and III, "on" state) were randomly assigned to three groups: Control (C, n=11, 62±3 years – regular care), CRT (n=13, 67±2 years – 2 sessions/week, 5 resistance exercises, 2-4 sets, 12-6 RM) and RTI (n=15, 65±2 years – same protocol as CRT, adding instability accessories at the bases of body support). Before and after 12 weeks, all the patients underwent a maximal cardiopulmonary exercise test conducted on a cycle ergometer (ramp protocol). Heart rate (HR), oxygen uptake (VO<sub>2</sub>) and systolic blood pressure (SBP) were assessed at rest, anaerobic threshold (AT), respiratory compensation point (RCP) and peak exercise. HR decay at 1 min of recovery ( $\Delta$ HRR1) was also measured. Data were compared by a 2-way ANOVA ( $P \leq 0.05$ ) and are presented as means±SE. Results: After 12 weeks, VO<sub>2</sub>peak increased similarly in all the groups (C: 17.8±1.7 vs. 18.6±1.8 ml.kg<sup>-1</sup>.min<sup>-1</sup>, CRT: 18.0±1.2 vs. 18.8±1.2 ml.kg<sup>-1</sup>.min<sup>-1</sup>, RTI: 19.0±1.3 vs. 20.3±1.2 ml.kg<sup>-1</sup>.min<sup>-1</sup>,  $p \leq 0.05$ ). HR and SBP measured at rest and during exercise did not change in any group (HRpeak, C: 146±6 vs. 142±6 bpm, CRT: 126±7 vs. 128±8 bpm, RTI: 131±4 vs. 133±4 bpm, respectively,  $p > 0.05$  / SBPpeak, C: 171±7 vs. 169±8 mmHg, CRT: 160±5 vs. 167±6 mmHg, RTI: 167±4 vs. 168±6 mmHg, respectively,  $p > 0.05$ ).  $\Delta$ HRR1 also did not change in any group (C: 13±3 vs. 12±3 bpm, CRT: 7±2 vs. 8±2 bpm, RTI: 11±3 vs. 14±2 bpm,  $p > 0.05$ ). Conclusion: None of the training regimes (CRT and RTI) promoted any adaptation on cardiovascular and metabolic responses at rest, during and after a maximal cardiopulmonary exercise test in patients with PD. Financial support: CNPQ. CAPES and CEPID-SONO.

#### IS PHYSICAL FITNESS ASSOCIATED WITH FIBROMYALGIA SEVERITY? THE AL-ÁNDALUS PROJECT

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Objective: Fibromyalgia represents a burden for the health care system, with the highest unemployment rate (6%), claims for disability benefit (up to 30%), and greatest number of days of absence from work in Europe (Leadley et al., 2012; Rivera et al., 2009). Physical fitness is a powerful marker of health and disease and could potentially be associated with a lower disease severity in this population. The aim of this study was to assess the association between physical fitness and fibromyalgia severity in women. Methods: This cross-sectional study involved 444 patients with a diagnosis of fibromyalgia according to the American College of Rheumatology criteria. Fibromyalgia severity was assessed with the Revised Fibromyalgia Impact Questionnaire (FIQR). Aerobic fitness (6-minute walk test), muscle strength (handgrip strength, chair-stand, and arm-curl tests), flexibility (chair-sit-and-reach and back-scratch tests) and motor agility (8 feet-up-and-go test) were measured with the Senior Fitness Test battery and digital dynamometry. A standardized composite fitness score ('global fitness profile') was calculated and divided into quintiles. Results: Overall, higher physical fitness was significantly associated with lower fibromyalgia severity, regardless of the fitness test evaluated (all,  $P < 0.05$ ). Participants in quintile 5 (highest 'global fitness profile') had 16% (95% CI: 8.8% to 22.1%;  $P < 0.001$ ) lower fibromyalgia severity than participants in quintile 1 (lowest 'global fitness profile'). Conclusion: Our results suggest that higher physical fitness is consistently associated with lower fibromyalgia severity in women with fibromyalgia. Women with the highest fitness levels had significantly lower fibromyalgia severity (-16%) than participants with the lowest fitness levels, which surpasses the minimal clinically meaningful difference in fibromyalgia. These results might have important implications for the rehabilitation of women with fibromyalgia. References: Leadley, R. M., Armstrong, N., Lee, Y. C., Allen, A., & Kleijnen, J. (2012). Chronic diseases in the European Union: the prevalence and health cost implications of chronic pain. *Journal of Pain & Palliative Care Pharmacotherapy*, 26(4), 310-325. Rivera, J., Rejas, J., Esteve-Vives, J., & Vallejo, M. A. (2009). Resource utilisation and health care costs in patients diagnosed with fibromyalgia in Spain. *Clinical and Experimental Rheumatology*, 27(5 Suppl 56), S39-45. Contact: asm@ugr.es

### Oral presentations

#### OP-PM29 Sports Medicine & Orthopedics: Exercise therapy, epidemiology

##### THE RELATIVE AGE EFFECT AND INJURIES IN CHILDREN'S FOOTBALL

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1Department of Sport, Exercise and Health, University of Basel, Basel, Switzerland 2FIFA-Medical Assessment and Research Centre and Schulthess Clinic, Zurich, Switzerland 3Medical School Hamburg, Germany 4Department of Orthopaedics, Charles University and Hospital, Prague, Czech Republic Introduction Physical fitness determines performance in football. Hence, maturation status may be relevant

for succeeding and relatively younger children may refrain from sport participation. The relative age effect (RAE) is known as the circumstance of being selected into a representative team with increased likelihood when born early in the year.<sup>1</sup> We analysed if "RAE" is present in children's football (average level of play). As maturation status may also affect injury risk,<sup>2</sup> we were interested if injury risk and injury severity differ between relatively younger and older children. Methods In a prospective observational cohort study over 2 years we collected injury and exposure data in 7 to 12 years old football players. In total we recorded 6038 athlete seasons. Players were divided into 4 birth quarters (BQ). Number and severity of injuries (lay off time in days) and anthropometric data were analysed. One-way ANOVA was used to compare anthropometrics between BQ. Chi2-statistics were used to compare injury data between BQ. Results Players' mean age was 9.5 yrs (SD 2.0). Mean height and weight were 1.36 m (0.12) and 31.0 kg (7.7), respectively. In total 417 injuries occurred. Average lay off time was 18.9 days (27.1). Players were more often ( $\chi^2=152.26$ ;  $P<0.001$ ) born early in the year (BQ1: 29.4%; BQ2: 28.5%; BQ3: 24.0%; BQ4: 18.2%) and also injured players were more often ( $\chi^2=27.86$ ;  $P<0.001$ ) born early in the year (BQ1: 32.6%; BQ2: 29.7%; BQ3: 21.1%; BQ4: 16.5%). BQ-distribution of the whole sample did not differ ( $p=0.29$ ) from injured players. Relatively older players were taller and heavier ( $P<0.001$ ;  $\eta^2\geq 0.01$ ) but there were no differences in height and weight of injured children between BQ ( $P\geq 0.26$ ;  $\eta^2\leq 0.14$ ). In all four BQ injured players were taller and heavier ( $P<0.001$ ;  $\eta^2>0.02$ ) compared to non-injured players. There was no difference in injury severity between BQ ( $P=0.69$ ;  $\eta^2=0.04$ ). Discussion RAE is especially known from high-level youth sport.<sup>1</sup> RAE was reported for 10-15 years old injured ice hockey players in higher levels of play but not for low or intermediate levels.<sup>3</sup> In our study, RAE was present in the whole sample and in injured children with no differences between BQ in injury risk and severity. Increased height and weight might be risk factors in children's football. References 1 Helsen WF, van Winckel J, Williams AM. *J Sports Sci.* 2005;23(6):629-636. 2 Faude O, Rößler R, Junge A. *Sports Med.* 2013;43(9):819-837. 3 Wattie N, Cobley S, Macpherson A, Howard A, et al. *Pediatrics.* 2007;120(1):142-148. Contact roland.roessler@unibas.ch

### INCREASED PHYSICAL ACTIVITY IN CHILDHOOD REDUCES ADOLESCENT FRACTURE RISK - AN EIGHT-YEAR INTERVENTION STUDY IN 3 534 CHILDREN

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*Clinical Sciences*

Introduction Physical activity (PA) in childhood is associated with higher bone mass and better neuromuscular function, but the effect on fracture risk is not clear. Methods We conducted an intervention program with 40 minutes of moderate PA per school day for eight years in 1339 children aged six to eight years at study start. As controls served 2195 age matched children who continued with the national standard of 60 minutes of physical education per week. We registered objectively verified fractures in all these participants. In a sub-cohort of 234 children we also measured bone mineral content (BMC) and bone mineral density (BMD) at the total spine with dual energy X-ray absorptiometry, and muscle strength in knee extension and flexion by a computerized dynamometer (Biodex®). We calculated annual fracture risk ratios (RR) as well as changes in bone mass and muscle strength. Results The RR of fractures decreased with each year of extended PA ( $r=-0.86$ ,  $p=0.007$ ) so that the RR after eight years [RR 0.48 (0.25, 0.91)] was lower in the intervention than in the control group. The gains in BMD and knee extension and flexion were greater in the intervention than in the control group (all  $p<0.001$  to  $<0.05$ ). Discussion A population-based pediatric PA intervention program reduces adolescent fracture risk, probably due to PA-induced benefits in BMD and muscle function. Contact marcus.coster@med.lu.se

### SOCCER INJURIES IN SWITZERLAND

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Introduction Soccer injuries are financially relevant and therefore constitute an important public health issue. According to the study „Sport Schweiz“ (Lamprecht et al., 2014) approximately 480'000 persons aged between 15 and 74 years are playing soccer in Switzerland. All in all, every third of them is licenced (SFV, 2013). The large number of players leads to a lot of soccer related injuries. For methodical reasons a lot of studies about the injury risk in soccer concentrate on professional soccer and a few studies focus on amateur soccer. As a consequence, there is incomplete knowledge about the context of injury events when soccer is played informally. Therefore, the aim of this study was to learn more about the context and characteristics of all soccer injuries in Switzerland to provide a basis for further improvements in injury prevention. Methods The support of the Suva allowed us to retrospectively consult a random sample of persons insured by Suva who had sustained an injury while playing soccer between July 1, 2013 and June 31, 2014. A total of 822 persons participated in the standardised telephone survey which took 16 minutes on average. Results Around 30% of the injuries occurred in informal soccer (free time with friends/family, informal tournaments etc.) whereas 70% came up in formal soccer (50% game, 20% practice). In addition to the injured body region and injury type, the collected data include details concerning the injury severity, previous injuries, rehabilitation and the injury situation (such as player to player contact, foul play, referee's response). Furthermore the interviewed persons provided information about their fitness levels and preventive behaviour, their soccer skills and tackle behaviour as well as about the ground conditions, footwear and shin guards. Discussion This study will provide new findings regarding the settings in which soccer injuries occur, different injury types and injury mechanisms. According to the literature, a previous injury (Hägglund et al., 2006) and player to player contact (Schmikli et al., 2011) are regarded as important risk factors for suffering another injury. Additionally, about 20% of injuries occurring during an official game are caused by foul play punished by the referee (Aoki et al., 2012). References Aoki H, O'Hata N, Kohno T, Morikawa T, Seki J. *Am J Sports Med* 40(5): 1006-1014, 2012. Hägglund M, Waldén M, Ekstrand J. *Br J Sports Med* 40: 767- 772, 2006. Lamprecht M, Fischer A, Stamm H. *Sport Schweiz* 2014: Sportaktivität und Sportinteresse der Schweizer Bevölkerung. Schmikli SL, de Vries WR, Inklaar H, Backx FJG. *J Sci Med Sport* 14: 199-203, 2011. Jahresbericht Schweizerischer Fussballverband (SFV) 2013. Contact ange-la.gebert@lssfb.ch

### CHARACTERISTICS AND RISK FACTORS OF SPORT INJURIES IN PHYSICAL EDUCATION STUDENTS: PRELIMINARY RESULTS

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Introduction Sport injuries can have a major impact on the career of Physical Education (PE) students. They can lead to physical limitations, absence from sport classes and study delay. This study aims to investigate the magnitude of the injury problem and to explore the risk

factors for sustaining an injury in PE students. Methods Dutch first-year PE students are followed during the academic year 2014-2015. Prior to the start of the academic year, all PE students underwent a sports medical exam, performed a maximal Interval Shuttle Run Test (ISRT) and filled in a baseline questionnaire. During the follow-up period students fill in an online questionnaire every 5 weeks for retrospective registration of time-loss injuries. Results In total, 292 students were included in this study (70% men and 30% women) with a mean age of 19.6 ( $\pm 2.1$ ) years. During the first 15 weeks of the study 670 follow-up questionnaires were returned and 247 injuries were registered by 174 students (59%). Students reported on average 267 ( $\pm 205$ ) minutes of extracurricular sporting time per week. On average, 690 minutes of intracurricular sport classes were scheduled. Preliminary results show an average time loss duration of 17 ( $\pm 17$ ) days, with a range of 1-85 days and a median of 10 days. Most injuries occurred during intracurricular sport classes (56%) and were acute (64%). Injuries occurred most frequently during soccer (27%), gymnastics (23%), other activities (21%) and martial arts (6%). The most common localizations were knee (15%), ankle (15%), lower leg (12%) and lower back (9%). Significant risk factors for sustaining an injury are an injury in the previous year ( $p < 0.01$ ) and an injury at the start of the academic year ( $p < 0.01$ ). Other possible risk factors were not significantly associated with sustaining an injury: gender ( $p = 0.06$ ), chronic illness ( $p = 0.21$ ), age ( $p = 0.43$ ), sporting hours prior to the start of the academic year ( $p = 0.10$ ), ISRT score ( $p = 0.44$  for men and  $p = 0.42$  for women) and extracurricular sporting time ( $p = 0.92$ ). Discussion The risk of sustaining an injury is high for first-year PE students and this can be considered as an extensive problem. Intracurricular sport classes are a substantial cause of sport injuries. Injuries most often involved the lower extremities. Important risk factors are an injury in the previous year and an injury at the start of the academic year. Contact s.bliekendaal@hva.nl

### EFFECTS OF WEIGHT LOSS AND ISOTONIC CORE EXERCISE OF 8 WEEKS ON PAIN, STRENGTH AND BALANCE IN OBESE MIDDLE AGED WOMEN WITH LOW BACK PAIN

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Introduction Low back pain (LBP) is a common musculoskeletal disorder (Alexopoulos et al., 2003), LBP is caused by obesity, poor muscle strength, and reduced spinal mobility (Bayramoglu et al., 2001). LBP has been not only pain and trunk muscle weakness, but also poor balance control caused of deficit in proprioception in the spine and alter muscle control (Bouche et al., 2006). Therefore, the purpose of this study was to determine the effects of weight loss and isotonic core exercise on low back pain, core muscle strength/body weight, and balance strategy in obese middle aged women with LBP. Methods Eighteen obese middle aged women with low back pain (waist-hip ratio; WHR  $\geq 0.85$ ) were divided to weight loss and isotonic core exercise group (WL+CE,  $n = 6$ ), isotonic core exercise group (CE,  $n = 6$ ) and control group (CON,  $n = 6$ ). The goal of the weight loss was set loss of 0.5 to 1 kg body mass/week and, isotonic core exercise was performed for 1 hour, three times a week, for 8-week at 50 % their individual core muscle strength. Physical characteristics (body mass, BMI, % body fat, muscle mass, WHR), low back pain (ODI, VAS), core muscle strength/body mass (trunk extensor, trunk flexor, hip flexor) and balance strategy (balance, reaction time, adaptation) were measured before (pre), after 4-week (post) and 8-week exercise (post 1) each groups. Results WHR was significantly decreased in WL+CE after post and post 1 than pre ( $p < 0.05$ ). ODI and VAS were significantly decreased in WL+CE after post and post 1 than pre ( $p < 0.01$ ). Trunk extensor strength/body mass was significantly increased in WL+CE at 146° ( $p < 0.01$ ), 158° ( $p < 0.01$ ), 170° ( $p < 0.01$ ) and 182° ( $p < 0.05$ ) after post 1 than pre, Trunk flexor strength/body weight was significantly increased in WL+CE at 146° ( $p < 0.01$ ), 158° ( $p < 0.05$ ) and 182° ( $p < 0.01$ ) after post 1 than pre. Hip flexor strength/body weight was significantly increased in the WL+CE after post 1 than pre ( $p < 0.01$ ). However, weight, BMI, % body fat, body mass, reaction time, and adaptation were not significantly different between time and groups. Discussion Generally, acute weight reduction leads to decrease lean body mass such as decrease muscle mass, consequentially decrease strength and physical fitness (Elfhag & Rossner, 2005). However, the present study showed that weight loss and isotonic core exercise reduced low back pain, improved core muscle strength and balance compared with isotonic core exercise only, probably due to increased muscle strength and decreased body mass. Therefore, we suggest that obese patients with LBP need to performing combination of core muscle strengthening and weight loss in order to effectively decrease low back pain. References Alexopoulos EC, Burdorf A, Kalokerinou A. (2003). *Int Arch Occup Environ Health*. 76(4), 289-294. Bayramoglu M, Akman MN, Kilinc S, Cetin N, Yavuz N, Ozker R. (2001). *Am J Phys Med Rehabil*. 80(9), 650-655 Bouche K, Stevens V, Cambier D, Caemaert J, Danneels L. (2006). *Eur Spine J*. 15(4), 423-432. Elfhag K, Rössner S. (2005). *Obes Rev*. 6(1), 67-85. Contact {hoseh28@dankook.ac.kr}

## Oral presentations

### OP-PM45 Training & Testing: Teamsport III

#### THE EVALUATION OF VALIDITY AND RELIABILITY OF A NEW SOCCER SPECIFIC TEST

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*Dokuz Eylul University*

Introduction Maximal oxygen uptake is largely associated with match activity profile of soccer players (Helgerud, 2001). Therefore, maximal oxygen uptake is one of the most important indicator of physical performance in soccer. Soccer Specific Modified 1.5 Mile Run Test is a new field test which improved by modifying "Cooper 1.5 mile Run Test" with soccer specific movement pattern. The aim of this study was to evaluate the criterion and construct validity and reliability of Soccer Specific Modified 1.5 Mile Run Test. Methods Totally 48 athletes were participated in the study. To evaluate the construct validity, 16 athletes from other team sports (handball, basketball and volleyball) were recruited in the study in addition to 32 soccer players. Participants visit the laboratory once. Height, weight, body fat percentage and maximal oxygen uptake were measured during laboratory session. In subsequent 2-7 days, Soccer Specific Modified 1,5 Mile Run Test is performed two times in the soccer pitch with 2-7 days apart. Results Soccer players completed the field test in a shorter time, significantly ( $p < 0,001$ ). There is a significant, strong and positive correlations between maximal oxygen uptake and time to complete Soccer Specific Modified 1,5 Mile Run test in soccer players ( $r = 0,83$ ). However, there is no significant correlation between maximal oxygen uptake and time to complete Soccer Specific Modified 1,5 Mile Run test for athletes from other team sports. There is a significant, strong and positive correlations between two field test both groups ( $r = 0,91$ ;  $r = 0,87$  respectively). Discussion Soccer Specific Modified One and Half Mile Run Test is a valid test only for soccer players unlike the athletes from other team sports. Such a result may be caused according to soccer

specific movement pattern. So, criterion and construct validity and reliability of this new field test were shown in this study. References Helgerud J, Engen LC, Wisloff U, Hoff J. (2001). *Med Sci Sports Exerc.* 2001 Nov;33(11):1925-31. Contact mertunrar@gmail.com

### TIME-MOTION DATA ANALYSIS OF A SMALL-SIDED GAME PERFORMED BY YOUNG ELITE MALE SOCCER PLAYERS

Wenker, C.T., Stevens, T.G.A.

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**Introduction** Small-sided games (SSGs) are frequently used in soccer training to improve sport-specific fitness of players. Time-motion data analysis has previously shown that distance and high speed running decrease during SSGs, most likely due to fatigue. Recently, it has been argued that including acceleration, deceleration and metabolic power estimations could improve the quantification of training load (1). The aim of the present study was to investigate whether distance covered at high acceleration (HA), high deceleration (HD), and high metabolic power (HP) show a similar fatigue related decrease during an intense SSG compared to the traditionally reported parameters total distance covered (TD) and high-speed running (HSR). **Methods** 47 young elite male soccer players (18±2 years) performed a 6v6 (including goalkeepers) 4x5 min SSG with 2 min passive recovery between game parts (pitch size: 40x34m). Time-motion and heart rate (HR) data were collected using a LPM system (Inmotio, Amsterdam, The Netherlands). Metabolic power was estimated with the 'di Prampero' equation (2) with 1.1 as terrain constant and 4.15 J/kg/m for energetic cost of constant running (1). HR, TD, distance ran above HSR (> 14.4 km/h), HA (> 2.0 m/s<sup>2</sup>), HP (> 20 W/kg), and distance below HD (< -2.0 m/s<sup>2</sup>) during the subsequent game parts were analyzed with a repeated measures ANOVA (level of significance p=.05). The study was approved by the local ethics committee and players signed informed consent. **Results** HR slightly increased from first (175±10 bpm) to second game part (177±10 bpm) and subsequently stabilized. In contrast, decreases were demonstrated from the first to the fourth game part for TD (659 to 588m; -11%), HSR (135 to 107m; -21%), HA (63 to 52m; -18%), HD (59 to 48m; -18%), and HP (156 to 127m; -19%). This decrease was greater for HSR and HP compared to TD, while the decline for HA and HD was not significantly different from TD. **Conclusion** Young elite soccer players demonstrated decreases for TD, distance above HSR, HA, HP, and distance below HD from the first to the fourth game part of the 6v6 SSG. Since the HR remained at a high level (constant from game part 2 to 4), it is likely that these reductions are associated with peripheral fatigue rather than a decrease in motivation. The greater decline for HSR and HP compared to TD suggests that fatigue may affect these measures differently. **References** 1. Stevens TGA, de Ruijter CJ, van Maurik D, van Lierop CJ, Savelsbergh GJ, & Beek PJ. Measured and Estimated Energy Cost of Constant and Shuttle Running in Soccer Players. *J. Med Sci Sports Exerc.* 2014. published ahead of print. 2. Di Prampero PE, Fusi S, Sepulcri L, Morin JB, Belli A, Antonutto G. Sprint running: a new energetic approach. *J. Exp. Biol.* 2005. 208, 2809-2816.

### SALIVARY BIOMARKERS ACROSS A YOUNG SOCCER SEASON

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**Introduction** The aim of this study was: 1) to examine monthly immunological and hormonal adaptive response to training in young soccer players across during an entire competitive season; and 2) to verify the relationship between the immune parameters and the incidence of upper respiratory symptoms (URS - Rama et al, 2013; Spence et al, 2007). **Methods** Players of three soccer teams belonging to the same Portuguese club Under-15 (n=17, age:14.8±0.2yrs, height:170.8±6.6cm, body mass:60.1±9.5kg, body fat:14.8±3.8%), Under-17 (n=22, age:16.1±0.4yrs, height:174.4±6.7cm, body mass:67.0±8.1kg, body fat :14.1±3.0%), Under-19 (n=18, 18.8±0.2yrs, height:177.5±6.9cm, body mass:70.9±8.1kg, body fat:13.3±4.9%), were monitored from the beginning (July 2013) to the end (April 2014) of a competitive season. Monthly, after a rest day and before the first weekly training session, saliva samples were collected at rest and analyzed for immunological (S-IgA concentration, S-IgA secretion rate, S-alpha amylase) and hormonal (cortisol C, testosterone T, T:C ratio) biomarkers. Signs and symptoms of URS were assessed through the WURSS-21 month log (Barret et al, 2005). Anova for repeated measures (p<0.05) was applied to investigate in season differences. **Results** No seasonal significant changes were found in cortisol, testosterone and T:C ratio. Regardless by age groups, a lower (p<0.05) in S-IgA secretion rate emerged at the end of the season. Moreover, while the Under-19 group showed increases in cortisol (p<0.05, ES=1.3) from February to March, the Under-15 group reported more cases of URS (+50% in December). **Discussion** The increased cortisol values in under-19 could reflect cumulative effects of training and competitions, which are similar to those of professional players. In addition the lower values of S-IgA secretion rate observed at the end of the season could be explained as an effect of training loads accumulation and may lead to a higher incidence of URS, especially in the youngest athletes. Thus, monitoring of salivary IgA could provide a useful and noninvasive tool to predict decreases in mucosal immunity (Mortatti et al, 2012), mainly in the younger athletes. **References** Barret, B, Brown, R et al. (2005). *Journal of clinical epidemiology*, 58 (6), 609-617 Mortatti AL, Moreira A, Aoki MS et al (2012). *J Strength Cond Res.* 26(5), 1396-401 Rama, L, Teixeira, AM, Matos et al (2013). *Eur J Appl Physiol* 113: 859-868 Spence, L, Brown, WJ, Pyne, DB et al (2007). *Med Sci Sports Exerc* 39(4): 577-586 not insert authors here

### PHYSICAL DEMANDS DURING VARIOUS TYPES OF CONSTRAINTS-LED CRICKET TRAINING

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**Introduction** Constraints-led training involves modifying the training environment to specifically tailor training sessions to focus on specific physical or skill demands. Constraints that can be modified include field size, player number and playing rules; all of which are suggested to be effective at promoting improved conditioning status within game simulations (Gabbett et al, 2009). This study aimed to examine the physical demands placed upon cricket players when modifications were made to the number of players, field size and playing rules during game simulation cricket training sessions. **Methods** The movement patterns and characteristics of 11 amateur, cricket players (batsmen, fast bowlers, spin bowlers, fielders, and wicketkeepers) were recorded via 10 Hz global positioning devices worn whilst performing four modified constraints-led cricket sessions. Modifications to training sessions included 1) reducing the field size, 2) decreasing the number of fielders, 3) a combination of reduced field size and fielder number and 4) altered playing rules (hit-and-run, continuous rotation of bowlers and all throws back to the wicketkeeper). Comparison of movement demands of each playing position between training sessions were determined using one-way ANOVA with Fisher's LSD post hoc (P<0.05). **Results** For batsmen, a main effect was evident for increased mean speed, total sprinting distance and a decreased work-to-recovery ratio (P<0.05) when playing rules were changed. For fast bowlers, the movement patterns did not differ between sessions (P>0.05), with the exception of increased walking distance (P<0.05) during the rule change session. No significant difference in physical demands were evident between sessions for spin bowlers or fielders (P>0.05). Wicketkeepers covered significantly greater striding distance and high-intensity efforts (P<0.05) combined

with a shorter work-to-recovery ratio during the rule change session. Discussion The use of modified constraints-led cricket training was able to influence the physical demands of amateur cricket players to varying degrees, depending on the session and playing position. Specifically, modification of the playing rules had the greatest influence on the movement patterns of the players, particularly for batsmen and wicketkeepers. The different constraints presents coaches with methods of providing sufficient training stimulus to maintain or improve the physical capacity of players, without compromising the amount of time spent in game-specific skill sessions. References Gabbett, T., Jenkins, D., Abernethy, B. (2009). *Int J Sports Sci Coach*, 4 (2), 273–283.

### ACUTE EFFECTS OF TWO DIFFERENT RESISTANCE CIRCUIT TRAINING PROTOCOLS ON PERFORMANCE AND PERCEIVED EXERTION IN BASKETBALL PLAYERS

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Introduction In basketball, shooting is the most important technical skill and vertical jump, agility and repeated sprint ability are amongst the main determinants of high performance. Resistance training, for strength/power development, is a common practice in this sport but little is known about the effects of different strength/power protocols on performance and post-resistance training fatigue. Hence, this study aimed to investigate the acute effects of two different resistance circuit training protocols on basketball players' physical and technical performance and rate of perceived exertion. Methods An intra-individual, crossover experimental design was used. Nine basketball players performed, on consecutive weeks, a Power Circuit Training (PCT; 45% 1RM) and a High Resistance Circuit Training (HRC; 6RM) (1). Vertical and horizontal jumps performance, 3-points shooting accuracy, repeated sprint ability (RSA), agility and upper body power output were measured the week before the first training session and following both circuit protocols. RPE was assessed 20 min post-resistance training. Results One-way rmANOVA showed performance decrements in vertical jump height and peak power, horizontal jump distance, 3-points shooting percentage, bench press power output, RSA total and ideal time and agility T-Test total time, following HRC but not PCT ( $p \leq 0.05$ ). RPE was higher in HRC compared with PCT ( $p \leq 0.05$ ). Discussion Results indicate that high intensity resistance training protocols are perceived as harder and result in higher levels of fatigue, which is in accordance with Linnamo's (2) findings. Moreover, HRC leads to acute physical and technical performance declines (3). Low-to-moderate intensity loads, however, don't affect negatively performance. Hence, PCT may be an appropriate option prior to a practice/game as it avoids acute resistance training-induced performance decrements but HRC may be a suitable alternative to develop/perfect technical skills under fatiguing conditions similar to that of competition. Nonetheless, strength and conditioning coaches should carefully plan strength sessions as augmented fatigue levels may lead to an increased risk of injury (4). References 1. Alcaraz PE, Pérez-Gómez J, Chavarrias M, Blazevich AJ. Similarity in adaptations to high-resistance circuit vs. traditional strength training in resistance-trained men. *J Strength Cond Res*. 2011 Sep;25(9):2519-27. 2. Linnamo V, Hakkinen K, Komi PV. Neuromuscular fatigue and recovery in maximal compared to explosive strength loading. *Eur J Appl Physiol Occup Physiol*. 1998;77(1-2):176-81. 3. Knicker AJ, Renshaw I, Oldham AR, Cairns SP. Interactive processes link the multiple symptoms of fatigue in sport competition. *Sports Med*. 2011 Apr 1;41(4):307-28. 4. Delextrat A, Trochym E, Calleja-Gonzalez J. Effect of a typical in-season week on strength jump and sprint performances in national-level female basketball players. *J Sports Med Phys Fitness*. 2012 Apr;52(2):128-36.

### PROPRIOCEPTION TRAINING: BEFORE OR AFTER REGULAR BASKETBALL TRAINING SESSION?

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*Tuzla University*

Introduction It is a common practice among strength and conditioning coaches to conduct proprioception training before a regular training session when athletes are in a rested state, but it is known that the majority of injuries occurred at the end of the training session, or competition, when athletes are fatigued (Hawkins and Fuller, 1999). Therefore, the aim of this study was to investigate the effects of basketball training on single-leg balance ability in rested and fatigued state and assess whether the efficiency of a proprioception program is affected by its performance before or after a regular basketball training. Methods Thirty-three female basketball players were randomly divided into three subgroups ( $n=11$  each). Experimental groups E1 and E2 performed the same proprioception program (8 weeks, 3 times per week, 15-20 minutes per session), but E1 performed before, and E2 after regular basketball training session. A control group performed only the regular basketball training. The Biodex Balance System was used to assess single-leg balance ability, overall stability index (OSI) prior to the utilization of the program (in rested and fatigued state), as well as after the program. General fatigue was induced by the beep test protocol. Two separate 3-way repeated measures ANOVA (time x group x condition) and multiple pairwise comparisons were used to test the differences in the single-leg balance ability between and within the groups pre- and post-proprioception program, and to determine if the timing of the proprioception training (pre-training vs. post-training) affected the balance ability in rested and fatigued state. Results The enhancement in single-leg balance ability for both dominant and non-dominant leg was higher in the experimental groups than in the control group ( $> 15\%$ ). Greater improvement was in a dominant leg's OSI in the fatigued and non-fatigued state in E2 group. E1 group showed similar improvement in the rested state for non-dominant leg compared to E2 group. Discussion We found that a basketball training improved single-leg ability, but greater enhancement was observed when the proprioception training was added. Additionally, we found that the post-training proprioception program positively affected balance ability in rested and fatigued state. These findings are in accordance with Gioftsidos et al. (2006). It seems that training in the fatigued state (post-training) has a positive transfer on single-leg ability in the fatigued state, so it is recommended to conduct it after training session or after exhausting exercises. References Hawkins RD, Fuller CW. (1999). *Br J Sports Med*, 33, 196–203. Gioftsidos A, Malliou P, Pafis G, Beneka A, Godolias G, Maganaris CN. (2006). *Eur J Appl Physiol*, 96(6), 659-64. Contact haris.pojškic@untz.ba



## Oral presentations

### OP-PM58 Health & Fitness: Children II

#### DETECTION OF MUSCLE IMBALANCES IN LOWER LIMBS STRENGTH AND POWER IN YOUNG CHILDREN AND ADOLESCENTS, AS AN INDICATOR IN THE PREVENTION OF INJURIES

López del Amo, J.L.1, Portas Uviña, A.2, Flores Fagnani, P.L.2, Moreno Galceran, D.2, Rovira Riba, N.2, Alba Jiménez, C.3, Padullés Riu, J.M.2

1: SPARG, UVIC (Vic, Spain), 2: UB-INEFC (Barcelona, Spain), 3: UVIC (Vic, Spain)

**Introduction** Functional assessment in young children and adolescents to detect muscle imbalances involving force and power in the lower limbs is a basic factor in injury prevention and in designing rehabilitation programmes to improve the health and performance of young people. New neuromuscular analysis technologies permit highly accurate and non-invasive clinical-functional assessment of human body movement. **Methods** This research used state-of-the-art technology to conduct tests on 177 subjects aged 12 to 17 at a Spanish secondary school (44.6% male and 55.4% female). This included Casio Ex F1 high-speed cameras, the Optogait platform of infrared rays for a treadmill, a vertical jumps platform connected to the Chronopic device, linear encoder connected to the MuscleLab device and Kinovea image analysis software. For the purpose of comparisons, the sample was divided into 4 sub-groups: males aged 12-13 (n=34), males aged 16-17 (n=45), females aged 12-13 (n=42) and males aged 16-17 (n=56). Kinanthropometric assessment tests, vertical jump and horizontal single-leg penta jump tests, walking analysis and tests to evaluate the strength of knee flexor and extensor muscles were conducted. Unilateral deficits, bilateral deficits and the conventional index for flexor and extensor muscles (Hamstring/Quadriceps Ratio) were calculated. **Results** The results detected muscle imbalances in 16.4% of students (those with muscle imbalances in 4 or more of the 9 tests conducted). The prevalence of muscle imbalances was significantly greater ( $p < 0.001$ ) in 12 year-old students than 16-17 year-old ones. Likewise, there were more cases of muscle imbalances in female students, with significant differences ( $p < 0.05$ ). The test with most differences, for both ages and sex, was the horizontal single-leg penta jump. The tests with most muscle imbalances were walking at 4 km/h (32.7%) and the Abalakov jump (28.8%). In groups, in all tests for which the bilateral deficit was calculated, the latter appeared more than bilateral facilitation did. **Discussion** Muscle imbalance, based on force and power performance, involves asymmetry of the agonist and antagonist muscles of a limb (Flexor-Extensor Deficit of the knee joint), asymmetry between the limbs (Unilateral Deficit) or a difference from an expected normal value (Bilateral Deficit). The calculation of these deficits generated around the knee joint may help identify risk factors for injury of the anterior crossed ligament and of the hamstring muscles (Croisier, 2004), the function of the knee joint and its dynamic stability (Aagaard et al., 1998; Gerodimos et al., 2003). **References** Aagaard, P.; Simonsen, E.B.; Magnusson, S.P.; Larsson, B & Dyhre-Poulsen, P. (1998). A new concept for isokinetic hamstring: quadriceps muscle strength ratio. *American Journal of Sports Medicine*, 26:231-237. Croisier, J.L. (2004). Factors associated with recurrent hamstring injuries. *Sports Med*, 34:681-95. Contact jl.lopez@uvic.cat

#### PARENTAL AND CHILD SPECIFIC FACTORS ASSOCIATED WITH PHYSICAL ACTIVITY IN FIRST GRADE SCHOOL CHILDREN.

Dreher, M., Hoffmann, S., Brendel, C., Simon, P.

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**Background:** Physical activity in children is known to be associated with the child specific factors overweight, TV viewing, computer use<sup>1</sup>, and the parental factors parental physical activity, overweight, smoking, and social status<sup>2, 3</sup>. Here we additionally studied the association of parental psychosocial inactivity, indecisiveness and sloth – here altogether termed idleness - with the physical activity of young children. **Methods:** 428 first grade school children were characterized with regard to anthropometrics and finished a German-Motor-Coordination test at 11 elementary schools in Mainz. In addition 316 of the respective parents responded to a self-administered paper and pencil questionnaire. Questions were asked about physical activity using the Baecke Questionnaire, idleness behavior factors, anthropometrics and social indicators. Contingency analysis and logistic regression analysis were used to estimate the association between physical activity of the children with the other parameters. **Results:** 4 of the 11 tested parameters were significantly and independently from each other related to physical activity of children. Child related factors associated with inactivity turned out to be watching TV for more than 30 minutes during a weekday, 3.19-fold (CI 1.86 – 5.57,  $p = < 0.0001$ ) or spending time in front of the computer and internet surfing during the weekend, 2.0-fold (CI 1.06 – 3.87;  $p = 0.034$ ). Parental factors were physical activity, 2.3-fold (CI 1.37 – 3.73;  $p = 0.0014$ ) and social activity/ idleness, 2.3-fold (CI 1.40 – 3.81;  $p = 0.0011$ ). **Conclusion:** Neither migration background, smoking habits and weight of parents nor on the weight of the child were associated with physical activity. Surprisingly both, idleness and physical inactivity of the parents but also media consumption of the children appear to be highly related to physical inactivity. All of these factors are principally amenable to be altered by targeted prevention intervention. **Literature:** 1: Marshall, S.J., Biddle, S.J.H., Gorley, T., Cameron, N. & Murdey, I. (2004). Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *International Journal of Obesity*, 28, 1238-1246. 2: Monasta L, Batty GD, Cattaneo A, Lutje V, Ronfani L, Van Lenthe FJ, Brug J (2010). Early-life determinants of overweight and obesity: a review of systematic reviews. *Obesity reviews* 11: 695-708 3: Hoffmann, S., Tug, S., & Simon, P. (2014). Child-caregivers' body weight and habitual physical status is associated with overweight in kindergartners. *BMC Public Health*, 14, 1-34. E-Mail: dreher@uni-mainz.de

#### A SYSTEMATISED REVIEW OF PRIMARY SCHOOL WHOLE CLASS CHILD HEALTHY WEIGHT INTERVENTIONS

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**Background** Childhood obesity is increasing at an alarming rate with projections suggesting that prevalence rates will continue to rise in developing countries.<sup>1</sup> School-based interventions for improving child healthy weight (CHW) are becoming more popular, but the degree of effectiveness remains unclear.<sup>2</sup> Therefore, a systematised review was conducted to determine the effectiveness of school-based interventions in reducing or stabilising BMI and to better inform the strategies and characteristic associated with interventions successful in improving BMI in primary school children. **Methods** A search of databases (PubMed, Health Source: Nursing/Academic Edition, MEDLINE, PsycBOOKS, Psychology and Behavioral Sciences Collection, PsycINFO, SocINDEX with Full Text, SPORTDiscus) for relevant publica-

tions was conducted and the data from included articles was synthesised. Studies selected for inclusion were school-based, whole class (all weight categories) with aims to improve BMI through increasing PA and improving dietary habits. Studies must have included BMI or BMI z-scores in pre and post analyses. This review included randomised and non-randomised controlled trials from years 2004 - 2014. Results Of the 1172 potentially relevant articles we identified, 18 studies met the inclusion criteria. From these 18 studies, 7 yielded a reduction or stabilisation in BMI or BMI z-score in the entire intervention group. Intervention durations ranged from 5 – 36 months. Five of these 18 studies used a combination of environmental, educational, and physical components, 5 combined educational and physical, 2 combined environmental and physical, 2 combined environmental and educational, and 4 used education only. Conclusions School based interventions that involve multiple environmental, educational, and physical strategies and not education only appear to be most likely to result in BMI or BMI z-score improvement. Moderators likely to influence BMI include increased physical activity (PA), decreased sedentary behaviours, lowered sugar sweetened beverages (SSBs), and increased fruit intake. REFERENCES 1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2014. 2. Lavelle HV, Mackay DF, Pell JP. Systematic review and meta-analysis of school-based interventions to reduce body mass index. *J Public Health (Oxf)*. 2012;34(3):360-9.

### **EFFECTS OF 12 WEEKS OF AEROBIC PLUS RESISTANCE TRAINING WITHOUT CALORIC RESTRICTION ON INFLAMMATORY MARKERS IN ADOLESCENT OBESE GIRLS**

Lopes, W.A., Leite, N., Silva, L.R., Brunelli, D.T., Radominski, R.B., Cavaglieri, C.R.

*State University of Maringá*

**Introduction** Exercise has been shown to be effective in reducing chronic inflammation associated with obesity. However, most research has been conducted in adults, so little is known about the anti-inflammatory effects of exercise in the pediatric population. Therefore, the aim of this study was to investigate the effects of 12 weeks of aerobic plus resistance training without caloric restriction on inflammatory markers in adolescent obese girls. **Methods** Thirty-three overweight adolescent girls (14.4±1.1 y; 1.61±0.05 m; 76.3±12.0 kg; 29.1±3.3 kg/m<sup>2</sup>) were randomly assigned to experimental (EG, n=17) and control group (CG, n=16). Body composition, aerobic fitness, muscular strength, dietary intake, glucose, insulin, lipid profile and inflammatory markers were measured before and after 12 weeks of intervention. The intervention program consisted in aerobic exercise (3 days/wk, 60 min, walking or running for 30 min, 50-80% VO<sub>2</sub>max) plus resistance exercise (3 sets of 6-10 reps at 60-70%1-RM). **Results** There was significant decrease in body fat (45.2±4.8 to 43.5±4.6 vs 45.4±5.9 to 46.0±6.3), and increase in VO<sub>2</sub>peak, 1-RM on leg press and 1 RM on bench press in the EG when compared to the CG. The insulin resistance by HOMA-IR reduced significantly in the EG (3.58±1.4 to 2.84±1.5 vs 3.69±1.9 to 3.64±1.4). In relation on inflammatory markers, there was significant decrease only in leptin levels (53.4±20.5 to 44.0±19.5 vs 58.6±26.9 to 63.5±24.0). CRP, IL-6, IL-10, TNF-α, resistin and adiponectin remained unchanged. **Discussion** Aerobic plus resistance training without caloric restriction was able to reduce body fat, insulin resistance and leptin levels in obese adolescent girls. These results corroborate Lemura & Maziekas (2002), who proposed that the combination of aerobic exercise and strength training is effective to decrease fat mass. Also, our results corroborate, in parts, Dãmaso et al. (2014), who showed that the combined aerobic training associated with multidisciplinary intervention was more effective in reducing leptin and increasing adiponectin levels than aerobic training alone. The absence of changes in some inflammatory markers in our study can be attributed to baseline value or to the small body fat reduction (Tam et al, 2010). **References** Lemura LM, Maziekas MT. (2002). *Medicine and Science in Sports and Exercise*, 34(3), 487-496, 2002. Tam CS, Clément K, Baur LA, Tordjman J. (2010). *Obesity Reviews*, 11,118-126. Dãmaso AR, Campos RM, Caranti DA, De Piano A, Fisberg M, Foschini D, Sanches PD, Tock L, Lederman HM, Tufik S, De Mello MT. (2014). *Journal Sports Sciences*, 14, 1-11.

### **CARDIORESPIRATORY FITNESS AND PHYSICAL ACTIVITY ON A MULTIDISCIPLINARY SCHOOL-BASED INTERVENTION IN CHILDREN : A RANDOMIZED CONTROLLED TRIAL.**

Batalau, R.1,2, Cabrita, P.2, Cruz, J.1, Gonçalves, P.1, Guerreiro, T.1, Santos, M.1, Gonçalves, R.1, Leal, J.3, Palmeira, A.2,4

*Lusófona University*

**Introduction** Most European children do not meet physical activity (PA) recommendations (Verloigne et al., 2012). So, obesity programmes focusing on PA have been suggested (WHO, 2009). This study is a part of Project PANK, a 6 months school-based multidisciplinary intervention to improve variables associated with cardiovascular and metabolic risk factors (CMRF). The main purpose is to analyse the impact of the intervention on PA and cardiorespiratory fitness (CRF) among Portuguese children. **Methods** Overweight and obese children (n=77, 7-10 y, both genders) were recruited. Intervention group (IG=40) had a PA intervention with 3 meetings for children and parents, an additional PA class (1h) and 6 educational sessions related to PA. At the same time, IG had a nutrition intervention with 3 meetings for children and parents and 6 educational sessions. Control group had no intervention. In IG, the CRF was assessed at baseline, after 3 and 6 months (20m shuttle run test). VO<sub>2</sub>max was estimated by Fernhall et al. (1998) (Fer) and Matsuzaka et al. (2004) (Mat) models. PA was assessed 6 times by accelerometers (GT3X) during 7 days. Evenson et al. (2008) cut-points were used. In CG, CRF and PA were assessed at baseline and after the program. **Results** The IG performed a higher amount of moderate PA (p=.014). Similar results were found in vigorous PA (p=.003). IG presented a higher number of moderate-to-vigorous PA bouts of 1-5 minutes when compared to CG (p=.008). No differences were found between groups in sedentary behaviours breaks. The IG shows higher levels of CRF when compared with CG (Fer Model: p<.001; Mat Model: p<.001). Partial correlation shows a positive association between the variance in vigorous PA since baseline to the end of intervention performed by IG and the variance of the CRF (Fer: p=.021; Mat: r=.42, p=.010). **Discussion** The PANK was effective in improving PA. Our results corroborate that it is possible to achieve improvements in CRF by increasing PA. The results in PA confirm that to achieve health benefits, the PA should be of at least a moderate intensity, but vigorous intensity activities may provide even greater benefit for children (Janssen and Leblanc, 2010). Considering the suggested independent impact of PA on metabolic syndrome and insulin resistance, alternatively or simultaneously mediated by the CRF and adiposity of youth (Guinhouya, et al., 2011), we will explore the possible influence of these results in the several CMRF studied. Evenson, R., et al. (2008). Calibration of two objective measures of PA for children. Guinhouya, C., et al. (2011). Evidence of the influence of PA on the metabolic syndrome and/or on insulin resistance. Janssen, I. et al. (2010). Systematic review of the health benefits of PA and fitness. Matsuzaka, A., et al. (2004). Validity of the multistage 20-m shuttle-run test. Verloigne, M., et al. (2012). Levels of PA and sedentary time among 10- to 12-year-old boys and girls.

## Oral presentations

### OP-SH11 Sport Statistics & Analysis

#### THE INFLUENCE OF PERFORMANCE LEVEL, AGE, AND GENDER ON PACING STRATEGY DURING A 100KM ULTRAMARATHON

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**Purpose:** To analyse the influence of performance level, age, and gender on pacing during a 100km ultramarathon. **Methods:** Results of a 100km race incorporating the World Masters Championships were used to identify differences in relative speeds in each 10km segment between participants finishing in the first, second, third, and fourth quartiles of overall positions (Groups 1,2,3, and 4 respectively). Similar analyses were performed between the top and bottom 50% of finishers in each age category, as well as within male and female categories. **Results:** Pacing varied between athletes achieving different absolute performance levels. Group 1 ran at significantly lower relative speeds than all other groups in the first three 10km segments (all  $P < 0.01$ ), and significantly higher speeds than Group 4 in the 6th and 10th (both  $P < 0.01$ ), and Group 2 in the 8th ( $P = 0.04$ ). Group 4 displayed significantly higher relative speeds than Group 2 and 3 in the first three segments (all  $P < 0.01$ ). Overall strategies remained consistent across age categories, although a similar phenomenon was observed within each category whereby 'top' competitors displayed lower relative speeds than 'bottom' competitors in the early stages, but higher speeds in the later stages. Females showed lower relative starting speeds and higher finishing speeds than males. 'Top' and 'bottom' finishing males displayed differing strategies, but this was not the case within females. **Conclusions:** Although pacing remained consistent across age categories, it differed with level of performance within each, possibly suggesting strategies are anchored on direct competitors. Strategy differs between genders, and differs depending on performance level achieved in males but not females. Contact: a.renfree@worc.ac.uk

#### EXPLORING SOME OF THE MYSTERIES OF COLLECTIVE COORDINATION IN FOOTBALL: EFFECTIVE PLAYING SPACE AND THE NUMBER OF PLAYERS.

Sampaio, J.1,2, Gonçalves, B.1,2, Folgado, H.1,3, Marcelino, R.1,2

1 *CreativeLab, Research Center for Sports, Health and Human Development (CIDESD)*, 2 *University of Trás-os-Montes e Alto Douro, Vila Real*, 3 *University of Évora, Évora*

**Introduction** To achieve collective behaviour that boosts high-level performances, football players are required to coordinate themselves into smaller sub-groups. The key variables that determine this optimal coordination are likely related to space, time and speed. This study aimed to identify how the number of players that constitute these sub-groups affects team coordination, as measured by the effective playing space (EPS, the smallest polygonal area delimited by the peripheral players, also providing information about the surface that is being effectively covered). **Methods** Twenty outfield football players from a Portuguese first league team participated in this study (age,  $24.8 \pm 3.9$  yrs; professional playing experience,  $7.1 \pm 4.0$  yrs). Positional data were collected using a 5Hz non-differential GPS during six pre-season matches. The EPS was calculated for sub-groups of 3, 4, 5, 6, 7, 8, 9 and 10 players, using the smallest inter-player distance as the selection criteria, i.e., the EPS from the sub-group of 3 players was constituted by the smallest polygonal area delimited by the 3 players who were nearer to each other. The results from these partial EPS situations were calculated in absolute values ( $m^2$ ) and also considering the amount of regularity (approximate entropy). The average speed of the players who formed each partial EPS was also calculated. The statistical comparisons were assessed via standardized mean differences and non-clinical magnitude-based inferences. **Results** The results from each of the six analysed matches were similar. The EPS area was higher with the increase in number of players, especially in the transition from 8 to 9 and 9 to 10 players. The correspondent regularity presented a most likely decrease trend (EPS3 vs. EPS4: difference in means:  $-25.5$ ;  $\pm 3.9\%$ ; mean,  $\pm 95\%$  confidence limits, to EPS9 vs. EPS10:  $-11.0$ ;  $\pm 3.1\%$ ), with magnitudes ranging from moderate to large. The predictability of EPS was especially higher in the transition from 8 to 9 and 9 to 10 players. The average speeds for each sub-group showed trivial/small differences (from EPS3 vs EPS4:  $7.06 \pm 0.22$  km/h, mean  $\pm$  sd, to EPS9 vs EPS10:  $6.86 \pm 0.21$ ). **Discussion** Collective coordination can be seen as a dynamic network that is formed by emergent behaviour originated in local sub-group relations. Current results allowed identifying how the increase in the number of players had the consequence of increasing predictability in EPS areas (as shown by approximate entropy). In addition, average speed results suggest that players achieve an optimal state of collective coordination between 6.5 to 7.5 km/h. The transition from 8 to 9 and 9 to 10 players were particular different from other EPS situations and should require extra attention when planning for representative tasks at the level of playing space and other environmental constraints such as game pace manipulation or player overloading/underloading.

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Winter, C., Pfeiffer, M.

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**Introduction** Recently, research concerning observational performance analysis in soccer has increased significantly. Nonetheless, most investigations neglect constituent properties of sports games (MacKenzie & Cushion, 2013). An alternative approach for notational analysis is presented that meets requirements for a meaningful analysis (especially the permanent procedural interaction). To create information crucial for coaches, a connection between the observations and success is established by means of artificial neural networks. **Methods** To gather meaningful tactical metrics, an observation model developed by Optikick® was used. Here, the main idea is to understand a soccer match as a system that is always in a certain state (Pfeiffer, Zhang & Hohmann, 2010). To score a goal the attacking team has to solve four different successive objectives: (1) Control the ball, followed by (2) a spatial progression and (3) the preparation of a scoring opportunity leading to (4) the shot on goal. Depending on the behaviour of the attacking team, the defence faces four corresponding tasks in addition to the omnipresent task to win control over the ball. The referees' decisions (interruptions, set plays and goals) complete the states. During a match a timestamp is recorded for each state transition and based on this data tactical metrics are calculated. For the study, 27 of the 31 games played at the UEFA Euro 2012® were analysed. The missing games included preliminary and final round matches of different teams, so that a systematic error is not expected. An artificial neural network (IBM SPSS 22) was used to classify if a team won, lost or drew depending on their tactical metric values. The data of 54 teams were divided into 75% training, 15%

testing and 10% hold-out. Training and classification process was calculated 20 times to reduce the possibility of a classification by chance. Results Inter-rater reliability showed excellent results (Cohens Kappa = .89;  $p < .05$ ). The artificial neural networks lead to 72.13% correct classifications. Only 7.84% of the winners were assigned to losers and 10% of the losers were assigned to winners. Discussion The successful classification reveals a connection between match success and the presented metrics. It should be highlighted that a wrong classification between winners and losers was very unlikely to occur. Tactical metrics describe different types of behaviour and, therefore, hold the opportunity to conduct meaningful recommendations for the training and coaching process. References Mackenzie, R. & Cushion, C. (2013). Performance analysis in football: a critical review and implications for future research. *Journal of Sports Sciences*, 31(6), 639–676. Pfeiffer, M., Zhang, H. & Hohmann, A. (2010). A Markov chain model of elite table tennis competition. *International Journal of Sports Science & Coaching*, 5(2), 205–222.

## FACTORS AFFECTING PERFORMANCE TIMES IN INTERNATIONAL LONG-TRACK SPEED SKATING

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**Introduction** Analysis of competition performances of elite athletes can provide not only the effects of environmental and other venue-specific factors but also estimates of within-athlete variability between competitions, which determines smallest important and other magnitude thresholds for studies of factors affecting performance. An analysis of speed-skating performance times is available only for elite 1000-m races over a season (1). The purpose of this study was therefore to analyze all six international long-track speed-skating events, focusing on short-term variability between races (2). **Methods** Official performance times in international elite events were downloaded from speedskatingresults.com for one Olympic cycle and analysed with a mixed linear model. The fixed effects were altitude (numeric linear), barometric pressure (numeric linear), type of rink (closed vs open), and competition importance (World Championships or Olympics vs World Cups). Random effects provided estimates of residual venue-related variability of mean performance times between races and of within-athlete variability between races within clusters spanning ~8 d. Effects were assessed with magnitude-based inference. **Results** The within-athlete race-to-race variability expressed as coefficients of variation ranged from 0.5% to 1.3%. There was a small difference in within-cluster variability between male juniors (0.8%) and female juniors (1.0%) but no difference between male and female seniors (both 0.6%). In relation to thresholds defined by these variabilities (0.3x through 4.0x for small through extremely large respectively), the effects of altitude per 1000 m were very large mean improvements in performance of 2.5% in juniors and 1.9% in seniors. An increase in barometric pressure of 100 hPa resulted in a large reduction in performance of 2.0% for juniors and an unclear effect for seniors. Only juniors competed in open rinks, where there was a very large reduction in performance of 3.2%. Junior and senior skaters showed a small increase in speed (0.5% and 0.3%) at the more important competitions. Residual venue-related variability was generally moderate to large. **Conclusions** The variability in performance times of speed skaters is a little less than that of elite track cyclists, another sport performed against air resistance. Converted to units of mean power (by multiplying by 2-3), the variability is about twice that of elite track runners, presumably reflecting variability in technique and power output between races. Interactions between athletes and the large environmental and venue effects may also contribute to the variability. These findings will be useful for researchers investigating strategies to enhance performance of elite speed skaters. **References** 1. Muehlbauer et al. *Res Q Exerc Sport* 2010;81:1-6. 2. Malcata & Hopkins. *Sports Med* 2014;44:1763-1774. Contact d.a.noordhof@vu.nl

## DOPING IN MASS SPORT: IN INEXPLICABLE PHENOMENON?

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Doping in mass sport is mostly understood within an (implicit) rational choice explanation, assuming that athletes try to maximize their benefit from engaging in elite sport by increasing their probability to reach high placements. At present, the phenomenon of doping in mass sport is increasingly focused by social scientific research as well as by Anti Doping Organizations although there is only little knowledge about the prevalence and the determinants of doping in this segment of sport. We conducted three empirical studies, investigating in the prevalence of doping in three different settings: (1.) among university students in four different European countries ( $n=8,224$ ), (2.) among sportsmen and -women in Palatinat (a region in Germany,  $n=1,930$ ) and (3.) among amateur cyclists, licensed by USACycling ( $n=3,756$ ). The research in all these studies was conducted using the Randomized Response technique in a webbased survey. This technique allows interviewees to answer embarrassing questions honestly without fear from social sanctions. The overall analysis showed that about 5 % of the participants in all these studies deliberately used forbidden substances or methods in order to increase their sporting performance. This percentage is somewhat lower than comparable results in elite sports but among the huge number of recreational sportsmen and -women we will nevertheless find a large number of deviators. The challenging issue for social sciences as well as for any Anti Doping measures is, that this behaviour cannot easily be explained by using similar patterns as in elite sport. Especially the influence of a monetary or non-monetary utility from high placements cannot be hypothesized as a driver for doping decisions in mass sports. By conducting comparative analyses over the three independent studies, we will describe which determinants are stable or unstable predictors of different doping prevalences. From these data, we will be able to formulate first assumptions, concerning the drivers for doping in recreational sport.

## PERCEPTIONS OF UK OLYMPIC AND PARALYMPIC SPORTS TOWARD ATHLETE SUPPORT SERVICES DELIVERED BY HIGHER EDUCATION INSTITUTES

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**Introduction** This study was part of a research project, funded by TSB, ESRC and ONE, which aimed to assess the requirements of sports for athlete support services based in Higher Education Institutes (HEIs) after the 2012 Olympic Games. **Methods** A questionnaire was developed containing a mix of 68 open and closed questions and administered to Performance Directors and High Performance Managers in summer and winter Olympic/Paralympic sports ( $n=55$ ) with 37 responding (62.7% return rate). **Results** Over 70% of respondents wanted to access facilities, athlete academic support and scholarship agreements with HEIs, although only 33-50% did. 75% were willing to receive more sport science support services from HEIs but only 47% did. Sports did not agree that HEI staff possessed adequate expertise in sports medicine, sports science, strength and conditioning, performance lifestyle, talent ID and research and innovation support services (5 point Likert scale 1=strongly disagree 5=strongly agree: mean values 2.31 to 3.13 SD 0.88-1.09). Sports reported that HEI sup-

port services would be worse than those delivered by the Home Country Institutes of Sport who employed specialised support staff (5 point Likert scale 1=a lot worse, 5=a lot better: mean 2.18, SD 0.87). Respondents agreed that practitioners based at HEIs had too much conflict with other University commitments (5 point Likert Scale 1=strongly agree, 5=strongly disagree: mean 2.15 SD 0.93). Non-the-less 88% of respondents indicated that they would be interested in joint funding a support post with a University due to: cost effectiveness (65%), sustainability (44%), staff development (42%), maintaining athlete support (38%) and staff retention (20%). Sports reported research collaboration as being beneficial (mean 4.08 SD 0.9; 5=large benefit, 1=no benefit at all) in terms of a performance (enhancing) impact (78%), with 44-50% also perceiving a benefit from the additional sport science testing support and educational impact involved for athletes and coaches. However only 45% of sports indicated they would actually like to see research and innovation provided by HEIs. When choosing an HEI to work with, sports reported in rank order of importance: location, cost, facilities, staff members, sporting reputation, academic reputation and being campus-based. Discussion Most sports perceived benefit from HEIs providing athlete support services, facilities, scholarships, academic support and research collaboration and would consider joint funded posts, however they had concerns regarding dedicated staffing and the quality of support services on offer; subsequently take-up of HEI services was less than 50%.

## Oral presentations

### OP-SH09 Psychology (Challenges within Sport Psychology II)

#### BREATHING EFFORT MORE THAN FLOW LINKS MUSIC TO AUTONOMIC HEALTH

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Introduction: Breathing efforts act upon the mechanism of the Respiratory Sinus Arrhythmia (RSA), an autonomic reflex which links respiration, blood pressure and cardiac regulation (Elghozi, Girard, Fritsch, Laude, & Petitprez, 2008), thus enhancing parasympathetic responses. Music and physical activity share other features such as Flow, an intrinsically enjoyable state that happens when there is a perceived balance between one's competencies and the demands of the task (Jackson & Roberts, 1992). Recent studies propose the use of Heart Rate Variability (HRV) (e.g. RMSSD), to quantify Flow (e.g. the challenge-ability balance dimension) (Keller, Bless, Blomann, & Kleinböhl, 2011; de Manzano, Theorell, Harmat, & Ullen, 2010), but to our knowledge, no study has analyzed the association between Flow and RSA in wind instrument players. Objectives: The present study aims to analyze the association between Flow and RMSSD changes in response to 2 wind instrument performances, different in terms of perceived difficulty. Methods: 8 male wind musicians (29.13±7.33 years; 69.36±10.31 kg) answered a questionnaire of flow "FSS-2" (Jackson & Eklund, 2002) following the 2 performances rated as difficult and easy, played on 2 alternate days with no audience. 2 segments of 20 minutes (Per1 & Per2), with 5 min of break, were retained for HRV analysis. The last 500 beats within each 20 min were analyzed (Kubios 2.1 software). Results: Opposite to RMSSD, which increased and even showed significant differences in the 2nd part of the hard performance ( $p < 0.05$ ), all Flow indexes went down as the difficulty increased, but not significantly (Wilcoxon test). Moreover, Challenge-hability balance showed a negative correlation with RMSSD at Per1 (Spearman,  $r = -0.752$ ;  $p = 0.032$ ) Discussion: Our results confirm the parasympathetic rebound due to the higher respiratory demands in the difficult performance, but suggest that this harder effort may become uncomfortable, and thus, related to the decrease in Flow, although not significantly. The autonomic benefits attributed to playing wind instruments through the RSA improvement, remain despite the fact that higher respiratory demands may lead musicians out of their comfort zone. REFERENCES: de Manzano, O., Theorell, T., Harmat, L., & Ullen, F. (2010). *Emotion*, 10(3), 301-311. Elghozi, J.-L., Girard, A., Fritsch, P., Laude, D., & Petitprez, J.-L. (2008). *Clin Auton Res*, 18(2), 96-104. Jackson, S. A., & Eklund, R. C. (2002). *J Sport Exerc Psychol*, 24(2). Jackson, S. A., & Roberts, G. C. (1992). *Sport Psychologist*, 6(2). Keller, J., Bless, H., Blomann, F., & Kleinböhl, D. (2011). *Exp Social Psych*, 47(4), 849-852.

#### THE VALIDITY AND RELIABILITY OF THE BEHAVIOURAL REGULATION IN EXERCISE QUESTIONNAIRE-2 AMONG RHEUMATOID ARTHRITIS PATIENTS

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Introduction Rheumatoid Arthritis (RA) is a chronic inflammatory disease that causes pain, stiffness and joint swelling. Health benefits of regular physical activity (PA) have been demonstrated for RA patients however their PA uptake is low (Yu et al., in press). Thus, it is important to examine the motivation for PA in RA patients. Grounded in Self-determination Theory (Deci & Ryan, 2000), the Behavioural Regulation in Exercise Questionnaire (BREQ-2) (Markland & Tobin, 2004) was developed to assess autonomous and controlled regulations (and amotivation) for PA and validated in healthy populations. It is often errantly assumed that questionnaires designed for such populations are appropriate for clinical groups. This study adopted a mixed methods (qualitative and quantitative) approach to examine the validity and reliability of the BREQ-2 in RA patients. Methods Study 1: the 'think aloud' procedure and a focus group were employed to examine the content validity of the BREQ-2 (n=6; M age=65 yrs). Study 2: 325 RA patients (96 (m), 229 (f); M age=57 yrs) completed the BREQ-2. The internal reliability of the subscales was assessed and the factorial validity was determined via confirmatory factor analysis (CFA). To examine criterion related validity, bivariate correlations were calculated with scores on the Subjective Vitality Scale and a measure of perceived capability and quality of life (ICECAP-A). Results RA patients reported no difficulties comprehending the BREQ-2 items and found the content suitable. Results of the reliability test and CFA suggested two items be removed and the fit of the data to the measurement model was improved (Chi square=225.05, CFI=.96, RMSEA=.057). Subscales exhibited acceptable internal consistency (alpha =.75-.93). As hypothesised, autonomous motivations positively correlated with subjective vitality and reported QOL. Controlled regulations and amotivation were either negatively or not correlated with these variables. Discussion Findings provide support for the internal reliability and factorial and criterion-related validity of a 17 item BREQ-2 when administered to RA patients. The BREQ-2 could be employed in future studies examining (a) the determinants of and outcomes associated with PA motivation, and (b) the impact of SDT-based PA promotion interventions in this clinical population. References Deci E, Ryan R. (2000). *Psychol Inquiry*, 11(4), 42. Markland D, Tobin V. (2004). *J Sport Exer Psych*, 26, 5. Yu C., Rouse P, Veldhuijzen van Zanten J, Ntoumanis N, Kitas G, Duda JL et al. (In press). *Arthritis Care Res*. Contact Chen-an Yu CX094@bham.ac.uk

## ASSESSMENT OF THE RECOVERY-STRESS STATE IN SKYDIVERS

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Introduction Skydivers are faced with a high amount of mental and physical demands (Chatterton et al., 1997). The ability to cope successfully with stress and to recover effectively is of great importance, especially in periods of intensive training such as a training camp. Heart rate variability (HRV) reflects autonomous nervous system activity and might be sensitive to indicate alterations in the stress-recovery state of skydivers caused by a high training load. Thus, aim of this study was to analyze i) alterations in the sympathovagal balance and ii) changes in the assessed actual recovery-stress state during the time course of a training camp. Method A sample of five male professional skydivers (age  $M = 30.2$  years,  $SD = 6.3$ ) completed a training camp in Florida that lasted 17 days. An electrocardiogram of the sleeping phase was recorded seven days before the camp in Austria and four times during the camp (day 2, 7, 12 and 16). A time segment of six hours (from 0:00 to 6:00 a.m.) was selected for analyzing HRV parameters. Additionally, the athletes filled out the stress-recovery questionnaire for athletes (REST-Q Sport; Kellmann & Kallus, 2000) three weeks before the camp and on the second and 16th training day. RM-ANOVA's (factor: time) were calculated with the values of HRV and REST-Q-scales. Results The mean of all normal beat-to-beat-intervals and the HRV parameters RMSSD, pNN50 und HFnu (normalized high-frequency power) demonstrated significant ( $p > .05$ ) or ten-dential ( $p < .08$ ) time effects ( $\eta^2$  between .47 and .69). The above mentioned values decrease from baseline to the second training day and show an increase to the 7th day. Subsequently, the parameters steadily decrease until the end of the camp. Significant or ten-dential time effects were obtained for the REST-Q-scales „general stress“, „lack of energy“, „physical recovery“ and „being in shape“ ( $\eta^2$  between .52 and .67) showing a decrease from baseline to the second day and an approximation to the baseline on the 16th training day. Discussion The decline in HRV from baseline to the second day reflects a reduced vagal activity that could be evoked to a large part by the jetlag. The temporal adaptation seems to be overcome until the 7th day expressed by an increase in vagal activity during night. The subsequent decreases in HRV may be caused by the mental and physical stress of the training. It is concluded that HRV is a sensitive indicator of the stress-recovery state in skydivers. References Chatterton Jr, R. T., Vogelsong, K. M., Lu, Y. C., & Hudgens, G. A. (1997). Hormonal Responses to Psychological Stress in Men Preparing for Skydiving 1. *The Journal of Clinical Endocrinology & Metabolism*, 82(18), 2503-2509. Kellmann, M., & Kallus, K. W. (2001). Recovery-stress questionnaire for athletes: user manual (Vol. 1). Human Kinetics.

## Oral presentations

### OP-PM46 Training & Testing: Fatigue I

#### THE UTILITY OF THE MULTI-COMPONENT TRAINING DISTRESS SCALE TO MONITOR SWIMMERS DURING PERIODS OF TRAINING OVERLOAD

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Introduction Athlete monitoring for optimising performance remains one of the greatest challenges for sport scientists and coaches alike. While strong and consistent relationships have been observed between self-report measures and performance, their use is not without limitations; such as timeliness of administration, and the potential time burden for athletes. Given the widespread use of the Recovery-Stress Questionnaire for Athletes – Sport (REST-Q), and its reported ability to show significant changes concurrently with training loads in swimming (González-Boto, et al., 2008), the aim of the present study was to assess the utility of the shorter MTDS (Main & Grove, 2009), compared with the REST-Q-Sport, to monitor swimmers preparing for the national championships. Methods Twenty-one national level adolescent swimmers completed eight weeks of testing. Once a week participants completed an 8 x 50 m sprint test, vertical jump test, sit-and-reach test, the MTDS and the REST-Q. All testing was incorporated into the swimmers' normal training program. Sequential regression was employed to determine if addition of the MTDS improved prediction of athlete performance beyond that afforded by the REST-Q. For exploratory purposes, a second sequential regression was performed where the order in which the two questionnaires were entered was switched to determine if the MTDS on its own provided greater predictive ability of performance than the REST-Q. Results On its own, the REST-Q accounted for the following variances in performance: flexibility (14.6%,  $p < 0.01$ ), power output (17.7%,  $p < 0.01$ ), swimming speed (15.5%,  $p < 0.01$ ) and swimming endurance (17.5%,  $p < 0.01$ ). In comparison, on its own the MTDS accounted for the following variances in performance: flexibility (12.1%, NS), power output (16.4%,  $p < 0.05$ ), swimming speed (20.5%,  $p < 0.01$ ) and swimming speed endurance (23.8%,  $p < 0.001$ ). Discussion The findings of the current study suggest that both the REST-Q and the MTDS have the capacity to predict performance on a range of fitness components associated with swimming. The REST-Q was more sensitive to predictions associated with swimmer flexibility and power output, while the MTDS was more sensitive to predicting actual swimming performance. References González-Boto, R., Salguero, A., Tuero, C., González-Gallego, J., & Marquez, S. (2008). Monitoring the effects of training load changes on stress and recovery in swimmers. *Journal of Physiol Biochem*, 64(1), 19-26. Main, L.C., & Grove, J.R. (2009). A multi-component assessment model for monitoring training distress among athletes. *European Journal of Sport Science*, 9(4), 191-198.

#### AQUA EXERCISE DOES NOT AFFECT RECOVERY OF PERFORMANCE, DAMAGE MARKERS, THE IMMUNE-STATUS AND SENSATION OF PAIN AFTER MUSCLE-DAMAGING EXERCISE.

Wahl, P., Sanno, M., Ellenberg, K., Frick, H., Boehm, E., Haiduck, B., Mester, J., Bloch, W.

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Introduction Aqua exercise might be an effective method of recovery from muscle damaging exercise, as the water resistance might induce mild massaging effects and hydrostatic pressure, and the exercise itself might increase muscle blood flow without inducing further eccentric actions, all reducing the oedema and inflammation. Therefore, the aim of the present study was to investigate the effects of passive recovery vs. aqua cycling on isometric and dynamic strength, markers of muscle damage, the immune status, muscle soreness and the perceived physical state (PEPS) after muscle damaging exercise. Methods 20 male subjects (age:  $24.4 \pm 2.2$ , weight:  $81.6 \pm 7.6$  kg) completed 300 maximal-effort counter movement jumps (CMJ) (one jump every 8 sec.). Afterwards, they were randomly assigned to either a passive recovery group (P) or an aqua-bike (AB) group, which performed 30 min of cycling in a pool. Before, directly

after the 300 CMJ, directly after the recovery session and up to 72h post, isometric and dynamic strength of leg extensor muscles, creatine kinase (CK), lactate dehydrogenase (LDH), and the immune status were measured. Furthermore, questionnaires on muscle soreness (visual analog scale (VAS)) and PEPS were completed. Results Maximal isometric and dynamic strength showed significant decreases in both groups of up to -20%. Number of repetitions at 30% of maximal isometric strength even decreased up to -35%, but showed a faster recovery than maximal performance. However, no significant differences were found between both groups in all measures of performance. Each of the four dimensions of the PEPS (health, flexibility, fitness, energy) and the VAS showed significant changes over time, however, no differences were found between groups. CK and LDH significantly increased over time and both parameters increased higher in the AB-group (CK: AB: +1325% vs. P: +864%; LDH: AB: +157% vs. P: +131%), but again no significant differences were found between AB and P. Also, measures of the immune status showed significant effects over time, but no significant differences between groups. Discussion The results of the present study showed, that a single 30min session of aqua exercise after 300 CMJ did not affect the recovery of muscle power, muscle soreness, the persons perceived physical state, markers of muscle damage and the immune status compared to passive rest. These results are in contrast to previous studies investigating the effects of aqua exercise on recovery (Takahashi et al. J Sport Sci. 2006), although aqua exercise was repeated on consecutive days in this study. Therefore, it might be concluded, that this kind of recovery intervention needs to be repeated more frequently to generate effects. Contact Wahl@dshs-koeln.de

### ACUTE FATIGUE OF LOWER LIMB AND TRUNK MUSCLES IMPAIRS STRENGTH, BALANCE AND SPRINT PERFORMANCE IN ACTIVE YOUNG ADULTS

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Introduction Balance, strength and sprint abilities are important performance prerequisites in various sports. Trunk and lower limb muscles are both considered relevant to control and maintain body functioning. To date there is scarce data available on the impact of either trunk or lower limb musculature on functional performance. We conducted a randomized controlled cross-over study to quantify the impact of isolated trunk muscle fatigue in comparison to isolated lower limb fatigue on strength, balance and sprint performance. Methods Twenty-four sport students (12 women; 23 (SD 3) y; 59 (10) kg; 1.65 (0.09) m; 12 men; 23 (3) y; 78 (9) kg; 1.81 (0.06) m) completed on three different days in randomized order either a trunk fatigue protocol, a lower limb fatigue protocol or a passive control condition. Before and after each fatigue protocol and the control condition, several performance tests were conducted in the following order: isokinetic strength (trunk as well as knee flexion and extension); static (tandem stance on a force plate) and dynamic (Y-balance test) balance; 20 m-sprint; agility and a prone plank test. The trunk fatigue protocol comprised repetitive trunk extension and flexion as well as loaded Russian twists. The fatigue protocol for the lower limbs included unilateral leg press (both legs), seated leg-curls and repeated counter-movement jumps. Exercises were repeated as circuit training for 20 min. Results Compared to the control condition, trunk fatigue resulted in impaired isokinetic trunk flexion strength (probability for the effect being practically meaningful: 100%; standardized mean difference: 1.13), prone plank (100%; 0.74), Y balance (87%; 0.31), agility (83%; 0.28) and tandem stance (89%; 0.45) performance. Lower limb fatigue negatively affected Y balance (100%; 0.64), agility (100%; 0.58), sprint (100%; 0.36), tandem stance (100%; 0.92) and prone plank (95%; 0.39) performance as well as trunk flexion (81%; 0.24) and knee extension (89%; 0.29) strength compared to control. Trunk flexion (100%; 0.93) and prone plank performance (97%; 0.37) were impaired after trunk fatigue relative to lower limb fatigue. Greater impairments after lower limb fatigue were observed for Y balance (87%; 0.33), agility (96%; 0.32), sprint (76%; 0.24) and tandem stance (78%; 0.38) performance as compared to trunk fatigue. Discussion We observed that a 20 min fatigue protocol, focusing either the legs or the trunk, impaired balance, strength and sprint performance. Particularly, balance and sprint performance were affected by lower limb fatigue. Although to a lower extent, isolated trunk fatigue also deteriorated these functional performance measures. Contact oliver.faude@unibas.ch

### THE EFFECT OF POST-EXERCISE CRYOTHERAPY ON RECOVERY CHARACTERISTICS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Introduction The effectiveness of cryotherapy on post-exercise recovery is predominantly described as the ability to decrease the inflammatory processes through reducing the local cell metabolism by inducing vasoconstriction. The aim of this review and meta-analysis was, to critically determine the possible effects of different cooling applications compared to non-cooling, passive post-exercise strategies on recovery characteristics after various, exhaustive exercise protocols. Methods A systematic literature search was conducted in the databases MEDLINE (PubMed), SportDiscus and PEDro between. A total of n = 36 articles were processed in this study. To establish the research question, the PICO-model, according to the PRISMA guidelines was used. The Cochrane's risk of bias tool was used for the quality assessment. Meta-analyses of subjective characteristics like delayed-onset muscle soreness (DOMS) and ratings of perceived exertion (RPE) and objective characteristics like blood plasma markers and blood plasma cytokines during a 96 hours (hrs) recovery period were performed. Results The overall risk of bias, especially for performance bias and detection bias, was high. Pooled data from 27 articles showed, that cooling and especially cold water immersion affected the symptoms of DOMS (up to 96 hrs) and RPE (up to 24 hrs) significantly compared to the control conditions. There was no evidence, that cooling affected objective recovery variables significantly. Discussion The majority of the studies had a high risk or an unclear risk of bias, which made the interpretation of the results uncertain. The main bias was produced with the blinding procedure. One main finding of this study was, that cold therapy (CWI) significantly alleviated the symptoms of DOMS 24 hrs, 48 hrs and 96 hrs after the cooling application. In this context it can be advised to take the amount of adipose tissue over the affected cooling area into account, because it can significantly affect the rate of intramuscular cooling. These findings are important for further studies because the effect of cooling could be highly influenced by the amount of adipose tissue. We had to spend much time for extracting data out of graphs or to contact researchers to obtain their data. Future studies should present their data e.g. as mean  $\pm$  SD and not only as graphs, without detailed description. References Moher D, (2009), J Clin Epidemiol, 62(10): p. 1006-12. Myrer WJ, (2001), J Athl Train, 36(1): p. 32-36 White, GE, Wells, GD, (2013), Extrem Physiol Med, 2(1): p. 26. Contact erich.hohenauer@sups.ch

## Oral presentations

### OP-PM73 Molecular Biology and Biochemistry: Age

#### EFFECTS OF DIFFERENT TYPES OF CHAIR BASED EXERCISE PROGRAMS ON HORMONAL, FUNCTIONAL AUTONOMY AND PHYSICAL FITNESS IN PRE-FRAIL ELDERLY WOMAN.

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**Introduction :** The main consequence of the immunosenescence is the decline of the functional autonomy (FA) and a satisfactory physical fitness (PF) state (Milte & Crotty, 2014). These factors are associated with elderly-frailty, whose common characteristic is psychophysiological stress. Cortisol (COR) is an essential hormone in the regulation of the stress response but recently, salivary alpha-amylase (sAA) has also emerged as a novel biomarker for evaluating stress (Maruyama et al., 2012). The aim of this study is to analyse the effects of different chair-based group exercise class programmes (CBE) on salivary COR and sAA levels, PF and FA in pre-frail elderly woman. **Methods:** The sample consisted of 61 female participants (age =  $82 \pm 7.30$ ) from four elderly care institutions. The participants were stratified according to the Frailty Phenotype developed by Fried et al., (2001) and divided into an four groups: a) aerobic 'walking' (AWE, n=23); b) Yoga/ flexibility (YTF, n=24); Elastic-band (E-BR, n=21) and control group (CG, n=21). To measure FA the Tinetti Falls Efficacy Scale (FES), Katz Index of Independence (ADL) and The Lawton Instrumental Activities of Daily Living (IADL) Scale were used. For measured PF, the Rikli & Jones 'Senior Fitness Test Battery' was used. The salivary levels of sCOR were measured by ELISA and sAA by a kinetic assay. All the tests were applied before and 14-weeks after the exercise CBE programme intervention in all the groups. **Results:** Our study revealed that cortisol levels increased slightly ( $p=.72$ ), but not significantly, unlike the alpha amylase activity, that decreased substantially in all the intervention groups ( $p=0.12$ ). No changes in the perception of the IDL and IADL were reported, however a significant decrease in RF, except for the CG was reported. The levels of physical FP improved substantially, except for the CG and the YTF groups. **Discussion:** The effectiveness mediation of the CBE programmes aiming at substantial improvements in overall health and PF of frail-elderly is scarcely present in the scientific literature (Robinson et al., 2014). A short increased in COR response is characteristic of the hormonal adaption to exercise (Maruyama et al., 2012). Moderate exercise programs in elderly populations may induce a lower sympathetic influence, which may explain the decrease in the alpha-amylase secretion. The decrease in the sAA activity could also be associated with an anti-inflammatory state through the increment on the para-sympathetic activity. The improvement in FP and the decrease in the RF show that even in this pre-frail old population, is possible to gain muscle strength and balance with CBE. **References** Fried, L. et al. (2001). The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 56(3) Maruyama, Y. et al. (2012). PloS One, 7(7), e39375. Milte, R., & Crotty, M. (2014). Best Practice & Research. Clinical Rheumatology, 28(3), 395–410. Robinson, K. R. et al. (2014). BMC Geriatrics, 14(1), 65. Contact Furts2001@yahoo.com.br

#### MICRORNA PROFILES OF SUBCUTANEOUS FAT TISSUE AND SERUM IN WOMEN – ASSOCIATIONS WITH AGE AND POSTMENOPAUSAL HORMONE REPLACEMENT THERAPY

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**Introduction** After menopause, women tend to gain weight due to accumulation of fat. Fat tissue is secretory organ contributing to inflammation. However, little is known about the contribution of fat to the circulating microRNA (miR) pool. This study aimed to investigate the similarities and differences of fat and serum miR pools in premenopausal women and in postmenopausal hormone replacement therapy (HRT) users and non-users. **Methods** Subcutaneous fat tissue and serum were used from a subsample of the SAWEs Study. It includes postmenopausal HRT discordant MZ twin pairs (Ronkainen et al 2009) and a cohort of premenopausal women with no hormonal treatment (Pöllänen et al 2011). Mature miR profiling was performed using an Applied Biosystem's human MicroRNA Array pool A. Target genes and pathways of specific miRs were identified using the DIANA-microT 3.0 (<http://diana.cslab.ece.ntua.gr/microT/>) as in Olivieri et al (2014). **Results** We found 11 miRs to be up- and 25 down-regulated in fat and 5 up- and 38 down-regulated in serum when postmenopausal women not on HRT were compared to premenopausal women (aging-effect). Only three of the identified miRs were found in both fat and serum. Most highly affected pathway by this miR profile was steroid hormone biosynthesis. When comparing MZ twins having used several years' HRT with their non-user co-twins, 13 miRs were found to be up- and 22 down-regulated in fat and 36 up- and 10 down-regulated in the serum of HRT users (HRT effect). Four miRs were found in both fat and serum samples. One of the significantly affected KEGG pathways was WNT signalling. We also compared the fat and serum miR profiles between premenopausal women and postmenopausal HRT users and found 12 up- and 26 down-regulated miRs in fat, 12 up- and 15 down-regulated miRs in serum and three shared miRs down-regulated both in fat and serum (anti-aging effect of HRT). Most significantly affected pathway was the TGF-beta signalling pathway. **Discussion** Fat and serum miR profiles and the potentially affected KEGG pathways showed both age and estrogen status related differences. These results emphasize the importance of miR-mediated regulation of aging process in fat. Furthermore, the role of circulating miRs in serum, as potential diagnostic markers of aging or hormonal status warrants further studies. **References** Ronkainen PH et al (2009) J Appl Physiol. 107:25–33. Pöllänen E et al (2011). Ageing Cell10: 650-60. Olivieri F et al (2014) Ageing Cell 13: 850-861. Contact vuokko.kovanen@jyu.fi

#### EFFECTS OF ELASTIC-BAND RESISTANCE TRAINING AND NUTRITIONAL SUPPLEMENTATION ON CIRCULATING MYOKINES AND MUSCLE QUALITY OF INSTITUTIONALIZED ELDERLY - THE VIENNA ACTIVE AGEING STUDY

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**Introduction** Ageing is associated with reduction of muscle mass and physical function, whereby strength training and adequate nutrition have revealed beneficial effects [1]. However, studies in very old people including mechanistic explanations are scarce. Therefore, the aim



of this study was to investigate whether circulating myokines (myostatin (MST), GDF-15, activin A, follistatin (FST), IGF-1), muscle quality (MQ) and functional parameters would be altered in response to resistance training with or without protein supplementation in institutionalized older people. Methods A total of 117 participants (103 females aged 82.5±5.9; 14 males aged 84.7±6.4) were randomly assigned to 3 groups (RT=resistance training, RTS=elastic-resistance training combined with protein supplementation, CT=cognitive training) and examined before, after 3 and at the end of 6-months of intervention with 2 sessions per week in each of the 3 groups. MQ was determined as the ratio of muscle strength or power and muscle mass [2]. Serum MST, FST, GDF-15, IGF-1 and activin A were measured by ELISA. Physical function was analysed using handgrip strength, chair rise test, arm lift test and 6 minute walking test (6MWT). To assess changes over time within the single study groups Friedman-tests were used. Results MQ increased in response to RT (+13%, p=.002) and RTS (+15%, p=.040). Additionally, performance improved in RT and RTS for chair rise test (RT +28%, p=.001; RTS +25, p=.003), arm lift test (RT +23%, p=.002; RTS +51%, p=.000) and 6MWT (RT +14%, p=.021; RTS +10, p=.015). These changes were accompanied by changes in FST (RT: +12%, p=.028; CT: -7%, p=.030) and activin A (RTS: +52%, p=.042; CT: -10%, p=.011), while IGF-1, MST and GDF-15 levels were not affected. At baseline, MQ correlated positively with all physical parameters and negatively with GDF-15 (p<0.05). Discussion Our data confirm that MQ and physical performance is increased by strength training even at an older age, whereas protein supplementation seems to be ineffective in further enhancing performance. As FST blocks the activation of activin A (and MST) [3] we hypothesize that the positive effects of strength training in elderly could be mediated by blocking muscle degradation pathways rather than inducing muscle growth, usually induced via IGF-1. However, this needs to be confirmed in further studies investigating the cellular mechanisms directly in skeletal muscles. References [1] Peterson MD, et al. (2010) Ageing Res Rev, 9(3): 226-37 [2] Barbat-Artigas S, et al. (2012) J Nutr Health Aging, 16(1): 67-77 [3] Gilson H, et al. (2009) Am J Physiol Endocrinol Metab, 297(1):E157-64 Contact marlene.hofmann@univie.ac.at

### HORMONE STATUS DEPENDENT DIFFERENCES IN MUSCLE PROTEOMICS: A STUDY WITH PREMENOPAUSAL WOMEN AND POSTMENOPAUSAL TWIN SISTERS DISCORDANT FOR THE USE OF HORMONE THERAPY

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Introduction. We studied the effects of menopausal status (pre/post) and effects of postmenopausal use of hormone replacement therapy (HRT) on skeletal muscle proteomics. Methods. The 24 female study participants were 6 healthy premenopausal women and 9 postmenopausal monozygotic twin sister pairs. Homogenized m. vastus lateralis samples were solubilized in 2D conditions using modified FASP protocol. The protein digests were separated and analysed using label-free nano-liquid chromatography tandem mass spectrometry (nano-LC-MS/MS) on a Synapt G2-S mass spectrometer (or ProteomicsTM Informatics software) were limited by including only those quantified with ≥2 unique peptides and p≤0.05 by ANOVA. The filtered lists of proteins with up/down-regulated expression were subsequently used in the Ingenuity Pathways Analysis (IPA, www.ingenuity.com). Results. In total, 918 proteins were identified, of which 662 were quantified and used in IPA comparisons. Of them, 223 were significantly differentially expressed in post- vs. premenopausal subjects (age-effect) and 136 in comparisons between postmenopausal HRT-users with their non-using co-twins (HRT-effect), p≤0.05 in both comparisons. Four most significantly associated canonical pathways revealed by IPA searches included: Mitochondrial dysfunction, Oxidative phosphorylation, Glycolysis and Calcium signaling (p-values ranging from 1E-8 to 2E-24). Analysis of downstream effects predicted an increase in the activity of Cell death and survival and decrease in Small molecule biochemistry pathways, portrayed as an age-effect, which were found to be reversed in HRT users. Discussion. We were able to identify proteome-wide differences in skeletal muscle of pre- and postmenopausal women and in HRT-users compared to non-using genetically identical twin sister. Our results indicate that both age and HRT associate with alterations in muscle energy metabolism. One of the major changes predicted to be increased in postmenopausal as compared to premenopausal state were related to cell death, while in HRT-use showed the opposite trend. These results indicate that estrogen exerts a regulatory role on muscle metabolism and processes of cell survival. However, it cannot be completely ruled out that the observed differences in post- vs. premenopausal state are due to aging per se and not due to difference in hormonal status. Contact: eija.pollanen@jyu.fi

## Oral presentations

### OP-PM52 Health & Fitness: Lifestyle I

#### INFLUENCE OF GENETIC POLYMORPHISMS ON RESPONSE TO PHYSICAL TRAINING IN HEALTH PARAMETERS

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Introduction The dramatic increase in average life expectancy highlights the importance of promoting a healthy aging and regular practice of physical exercise (Fried, 2004). It is also known that genetic polymorphisms may act in the expression of proteins and change features that modify the response to a practice of physical exercise (Ostrand et al., 2009). In this context, the purpose of this study was to analyze the effects of ACE I/D and ACTN3 R/X genetic polymorphisms on response to physical training in health parameters in women at the end of adulthood and early in the old age. Methods Fifty four women were genotyped (ACE I/D and ACTN3 R/X genetic polymorphisms) and based on these genetic characteristics they were shared in groups and trained during 12 weeks in an indoor sports court (two days a week and 90 min per day, mainly doing aerobic and strength exercises at level 13 to 15 on the Borg Scale). They also were submitted to measurements of height, body mass, body mass index, waist circumference, blood pressure and answered questionnaires related to quality of life (Short Form - 36 - Health Survey), levels of depression (Geriatric Depression Scale - GDS), psychological stress (Stress Symptoms Inventory - SSI) and sleep quality (Epworth Sleepiness Scale - ESS) immediately before and after this intervention period. The comparison between the averages of the different groups was performed by two-way repeated measures ANOVA and the significance level adopted was 5%. Results Related ACTN3 only the RR/XX group presented a reduction in body weight and systolic blood pressure after training, as well an improvement in quality of life and daytime sleepiness - and among these four variables the RR/XX group was only different of the XX group at the beginning (before training) in systolic blood pressure. On the other hand, despite only the II ACE have shown a reduction in body weight and body mass index after training, this group had presented at the beginning of training

higher values of body weight and body mass index. Discussion This is the first study related ACTN3 and ACE polymorphisms and the analysed variables. Regarding blood pressure, for example, there are some studies related NOS polymorphisms (Sponton et al., 2014). In conclusion, the RR/XX ACTN3 group presented better response to the exercise than the XX group, as well as the II group, despite its worse initial values when compared to the other groups. References Fried L (2004). *J Gerontol*, 59(3), 255-263. Ostrander E, Huson H, Ostrander G (2009). *Annu Rev Genomics Human Genet*, 10, 407-429. Sponton C, Esposti R, Rodovalho C, Ferreira J, Jarrete A, Anaruma C, Bacci Jr M, Zanesco A (2014). *Am J Physiol*, 306, 1679-1691. Contact buenojr@usp.br

### STABILITY OF LEISURE-TIME PHYSICAL ACTIVITY AND ALL-CAUSE MORTALITY IN TWINS DURING 23-YEAR FOLLOW-UP

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Introduction Many observational studies have reported that leisure-time physical activity has protective effect on all-cause mortality, however no randomized controlled trials conform this. As observational studies are not able to adjust for genetic selection, the aim of this twin study was to find out whether long-term (15 years) leisure-time physical activity, adjusted for genetic liability and childhood experiences, protect against all-cause mortality. Methods The prospective Finnish Twin Cohort includes all same-sex twin pairs born in Finland before 1958. Physical activity was measured with structured questionnaire. The stability and change in vigorous and volume of physical activity during 15-year baseline (activity measured in 1975, 1981 and 1990) were used as the baseline predictors. Altogether 11 325 twin individuals, including 4 190 complete twin pairs, had answered required physical activity questions in all three baseline time points. Cox proportional hazards model was used for mortality analysis starting from the 1990 response date until July 31, 2013. Results During follow-up period 1 478 individuals died. Decreased mortality was observed among individuals with continues vigorous physical activity (active in 1975, 1981 and 1990); age and sex adjusted hazard ratio (HR) of death was 0.55 (95 % CI 0.46-0.64) and full covariate adjusted HR including health status was 0.73 (0.61-0.88), while the fully adjusted HRs for activity increasers and decreasers were 0.86 (0.75-0.99) and 0.95 (0.78-1.16) respectively compared to individuals who had no vigorous activity during baseline years. Within pairwise analyses HR for continues vigorous activity was 0.65 (0.46-0.91) and fully adjusted was 0.72 (0.48-1.07). Also belonging to the highest third in volume of physical activity during 15 year baseline was associated with decreased mortality even in fully adjusted pairwise model (0.73, 0.54-0.98) when compared to the lowest third. No differences were seen in any of the analyses within MZ pairs with cotwins differing in physical activity profile. Discussion Continues vigorous physical activity and high volume of activity decreased mortality during a 23-year follow-up even among individuals without clinically overt disease. However, genetic selection may play a role in this as no difference was seen within MZ pairs. Contact katja.waller@jyu.fi

### POINTS-BASED PHYSICAL ACTIVITY: A NOVEL APPROACH TO PHYSICAL ACTIVITY PROMOTES IMPROVED BODY COMPOSITION IN OVERWEIGHT, INACTIVE WOMEN.

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1 U. of Birmingham, UK. 2 U. of Worcester, UK. Introduction: Fifty-eight percent of women in England are overweight or obese (Health and Social Care Information Centre, 2013). In addition, only 29% of women in England meet the recommended level of physical activity (Townsend et al., 2012), despite the health benefits of exercise being widely acknowledged. The aim of the current study was to investigate the effect of a points-based exercise intervention, offering greater flexibility and autonomy, on changes in cardiovascular fitness (CVF), body-weight (BW), and body composition (BC) in overweight, inactive women. Method: Seventy-six overweight, inactive women were randomly assigned to one of three groups: point-based exercise (PB; n=24, 40±7 yrs, 28.7±3.2 kg•m<sup>-2</sup>), traditional prescribed exercise (Pres; n=26, 41±7 yrs, 29.9±3.3 kg•m<sup>-2</sup>) or control (CONT, n=26, 42±7 yrs, 28.6±3.3 kg•m<sup>-2</sup>). Pres completed 30 minutes of moderate-intensity exercise, 5 times per week. PB attained 35 "Physical Activity Points" (derived from MET scores) each week, awarded for exercise and non-exercise physical activity of varying intensity and duration. CONT maintained sedentary behaviour. All participants were asked not to alter dietary habits. Measures of BW, waist and hip circumferences were obtained and BC was measured using Dual-X-ray Absorptiometry. A treadmill incremental exercise test to exhaustion was completed for the measure of maximal aerobic capacity (VO<sub>2</sub>max) and maximal fat oxidation (MFO). All measures were obtained at baseline, weeks 4, 12 and 24. Results: BW was significantly lower in PB at 24-weeks compared with baseline (74.2±8.7 kg vs. 77.7±9.3 kg, p=0.004). Change in BW was significantly greater in PB at 24-weeks (-3.3±5.9 kg) than in CONT (+0.7±2.6 kg, p=0.020). No change in BW was observed in Pres. Total fat mass was significantly lower at 12-weeks compared with baseline in PB (27.6±5.99 kg vs. 29.2±6.54 kg, p=0.005). Reduction in fat mass was significantly greater in PB compared with CONT at 24-weeks (-1.93±4.75 vs. +0.92±2.33 kg, p=0.045). Neither lean mass nor body fat percentage changed significantly in any condition. VO<sub>2</sub>max and MFO were unaltered with training. Discussion: A point-based approach to physical activity interventions may prove beneficial for improving BC, compared with traditional exercise programs. However, more strenuous exercise may be necessary to elicit improvements in CVF and increase lean mass to further enhance BC. References: Townsend N, Bhatnaga P, Wickramasinge K, Scarborough P, Foster C, & Rayner M. (2012). *Physical Activity Statistics 2012*. London. Health and Social Care Information Centre (2103). *Health Survey for England. Statistics on Obesity, Physical Activity and Diet - England, 2013*. Contact: Dr Adrian Holliday: a.holliday@worc.ac.uk

### THE EFFECT OF INTELLIGENT PHYSICAL EXERCISE TRAINING ON SICKNESS ABSENCE AND JOB PERFORMANCE AMONG OFFICE WORKERS: A RANDOMIZED CONTROLLED TRIAL

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Introduction Physical training may improve health and decrease the risk of sickness absence and low job performance. The aim of this paper was thus to investigate the effect of individually tailored intelligent physical exercise training (IPET) on sickness absence and job performance among office workers. Methods In a randomized controlled trial employees from six companies located across Denmark were allocated to a training group, TG, (N = 194) or a control group, CG, (N = 195). The TG received one-hour high intensity IPET every week within working hours, and was recommended to perform 30 minutes of moderate intensity physical activity six days a week during leisure time. The principles of IPET have previously been described in details (Sjøgaard, Justesen et al. 2014). Before and after the one-year intervention the office workers answered a questionnaire on work ability (ten-step ordinal scale), productivity (ten-step ordinal scale),

and health (five-step ordinal scale). These data were analyzed with ITT. Only short term absence in spells of 1 to 10 days were included in the sickness absence data. Adherence was calculated as the number of completed training sessions out of the total possible training sessions, which ranged from 34 - 37 between the six companies within the one-year time-period. For the per protocol analysis, we set a cut-point of  $\geq 70$  % for adherence. Results At baseline, there were no differences between training and control group. The participants were on average  $44 \pm 10.4$  years old, 75% were female and had an average BMI of  $25.4 \pm 5.1$  kg/m<sup>2</sup> and an average percentage body fat of  $29.1 \pm 8.8$ %. After one year, an ITT analysis showed that TG had a significant increase in workability from 8,7 to 9,0 ( $p = <0.001$ ), productivity from 8,2 to 8,6 ( $p = 0.054$ ) and general health from 3,5 to 3,8 ( $p = <0.001$ ) compared to the CG but there was no change in sickness absence between the two groups. A per protocol analysis, where 89 (46%) office workers participated  $\geq 70$  % showed a significant 6% improvement in job performance ( $p = <0.001$ ), and 56 % decrease in sickness absence ( $p = <0.001$ ) compared to the CG from baseline to one-year follow-up. Sickness absence were at baseline mean 4,4 days in TG and 3,5 days in CG. Discussion One-hour high intensity IPET in working hours combined with recommendations of 30 minutes daily leisure time moderate intensity physical activity improved job performance and decreased sickness absence if adhering to the intervention protocol. Overall, these results underline the effectiveness and corporate incentives of implementing IPET at the workplace. Reference Sjøgaard G., Justesen JB, Murray M, Dalager T, Sjøgaard K. (2014). BMC Public Health, (14), 652. Contact jrchristensen@health.sdu.dk

## Oral presentations

### OP-PM25 Physiology: Mixed session

#### FAT OR FIT: DOES BODY COMPOSITION OR FITNESS AFFECT IMMUNE AND INFLAMMATORY CHANGES OF FIREFIGHTERS IN THE HEAT?

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1: UCRISE (Canberra, Australia) 2: ESA (Canberra, Australia) 3: UW (Hamilton, NZ) Introduction When firefighters work in the heat, changes in immunity (Smith, DL et al., 2005) and inflammation (Wright-Beatty et al., 2014) occur, possibly increasing the risk of immunothrombosis. However, a risk profile for individuals regarding these changes is largely unknown. The present study aimed to establish whether differences in body composition and fitness affect the magnitude of immune and inflammatory changes of firefighters following work in a hot environment. Methods Forty-five urban firefighters (42 male, 3 female;  $40.1 \pm 8.6$  yrs,  $178.8 \pm 7.5$  cm,  $83.3 \pm 9.4$  kg) completed a standardised work task in the heat ( $100 \pm 5^\circ\text{C}$ ) consisting of two 20-min periods separated by a 10-min rest. Prior to heat testing, individuals were assessed using DXA for body-fat (BF) ( $20.8 \pm 7.2$  %), lean-mass (LM) ( $65.6 \pm 7.4$  kg) and anthropometric determination of BMI ( $26.2 \pm 2.2$  kg.m<sup>-2</sup>). Further, aerobic capacity (VO<sub>2</sub>) was assessed via open-circuit spirometry using the Bruce treadmill protocol ( $56.2 \pm 8.6$  ml.kg.min<sup>-1</sup>). Participants were separated based on each characteristic into tertiles for analysis (Low, Mod, High). Blood was collected at 4 time points (pre-work, post-work, post+1hr and post+24hrs). Participants completed a self-selected recovery protocol following the work task. Differences in Leukocytes, platelets, TNF $\alpha$  and LPS were then compared based on those tertiles. Results Overall increases in immune and inflammatory markers were observed following the work period, with platelets remaining elevated 24-hrs into recovery. Participants with higher levels of BF had significantly higher levels of leukocytes ( $p=0.01$ ) and TNF $\alpha$  ( $p=0.03$ ) at the four time points. Further, LPS was affected by differences in LM alone with the high tertile group demonstrating lower values than the low ( $p=0.04$ ). Platelet numbers were not affected ( $p>0.05$ ) by tertiles for any variable. Likewise, neither BMI nor VO<sub>2</sub> tertile distinguished levels of any immune or inflammatory variable. Discussion Differences in body composition, particularly BF and LM may play a predictive role in changes to immunity and inflammation in firefighters following work in the heat. On the other hand, neither BMI nor VO<sub>2</sub> played a role in the immune and inflammatory response of this cohort. Firefighters demonstrating high BF and/or low LM may experience higher levels of immune and inflammatory activity, which may be predisposing them to a greater risk of a thrombotic event. Focusing on improving body composition, independent of BMI may improve the safety of firefighters when they work in the heat. References Smith DL et al., (2005). Ergonomics, 1, 55-65. Wright-Beatty HE et al., (2014). EJAP, 6, 1163-74. Contact Anthony.walker@canberra.edu.au

#### GALECTIN-3 AND SUPPRESSION OF TUMORIGENICITY 2 MEASUREMENT IN PARTICIPANT AT THE "TOR DES GÉANTS"

Le Goff, C., Kaux, J.F., Gergelè, L., Millet, G.P., Viallon, M., Croisille, P., Cavalier, E.

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Introduction: Gal-3 is a carbohydrate binding lectin produced by macrophages, upregulated in hypertrophied heart, emerging as a mediator for fibrosis development and cardiac remodeling. ST2 is a family member of IL-1 receptors initially known for its role in immunological processes. It has a potential role in the cardiac pathogenesis. These receptors are led in cardiomyocytes and fibroblasts due to a mechanical stress. We aimed to examine the evolution of Gal-3 and ST2 in trailers who ran one of the most challenging ultra-marathon in the world: the Tor des Géants (330 km, altitude range: 24000m). Methods: Levels of plasma Gal-3 and ST2 were determined at 4 times: before the start, after 158km, at the end and 3 days after the end of the race in 33 trailers. Samples were directly centrifuged and frozen at  $-80^\circ\text{C}$ . Gal-3 measurement was performed on the VIDAS (Biomérieux) and ST2 was analyzed with the Presage ST2 Assay (Critical Diagnostic). The reference values are  $<17.8$ ng/mL for Gal-3 and  $<35$ ng/mL for ST2. Statistica was used for the statistical analysis (ANOVA). We calculated the difference between the different time and expressed in delta:  $\Delta 1=(T2-T1)/T1*100$ ,  $\Delta 2=(T3-T2)/T2*100$ ,  $\Delta 3=(T4-T3)/T3*100$ ,  $\Delta 4=(T3-T1)/T1*100$ ,  $\Delta 5=(T4-T1)/T1*100$ . After that, we tried to correlate the delta between them (results= R(p-value)). Results were considered as significant with  $p<0.05$ . Results: Plasmatic levels of Gal-3 did never exceed the cut-off of 17.8ng/mL, except for 1 trailer in T2. A slight increase of levels of Gal-3 was observed at T2 (min-max:7.5-17.6ng/mL). These ones did not vary a lot at T3 (min-max:7.0-18.8ng/mL) but return to normality at T4 (min-max:6.0-12.8ng/mL). For ST2, at T1, 12 subjects had plasmatic levels above the reference value of 35ng/ml. At T2, only 2 trailers blood samples were still in the reference interval. Indeed, a great increase of ST2 plasmatic levels observed (min-max:18.8-158.8ng/mL). A slight decrease of ST2 levels was observed at T3, but only one subject had a value below 30ng/ml (min-max:20.1-182.7ng/mL). However, a subject had still plasmatic levels above T2 values. A return to normality was observed at T4 with 16 trailers blood levels in the reference interval (min-max:12.0-56.4ng/mL). We observed an increase for Gal-3 and ST2, above the reference values only for ST2. We noted for both a decrease up to the normal values 3 days after the trail. For the correlation between deltas, we observed that Gal-3 and ST2 are correlated for each delta. Discussion: A logical correlation is observed between Gal-3 and

ST2 as they are involved in cardiac fibrosis and inflammation. But we do not know why it is not in the same proportion. We know that some trailers take NSAIDs and painkillers during the race. The results of this study demonstrate that this exercise was associated with biochemical abnormalities that may reflect adverse consequences on cardiac structure as fibrosis. However, ST2 values were higher, perhaps due to a mechanical stress more than a cardiac stress. Gal-3 is perhaps then more cardio-specific than ST2.

### EFFECTS OF PROLONGED LOW INTENSITY EXERCISE WITH ENERGY DEFICIT ON MARKERS OF MUSCLE PROTEIN TURNOVER.

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**Introduction** It is well known that ultra-endurance exercise, such as Adventure racing and military operations, often induce substantial energy deficits. This suggests a catabolic state, but the exact effects on protein turnover have not yet been sufficiently investigated. The aim of this study was to examine several markers involved in muscle protein turnover before and after a multi-day physically demanding military training operation. **Methods** Seven female (age  $21 \pm 5$  years, weight  $71.2 \pm 6.6$  kg) and seventeen male (age  $20 \pm 1$  years, weight  $76.6 \pm 6.2$  kg) performed a 185 hours military training operation. Energy intake was estimated from food supply and energy expenditure was calculated from continuous heart rate and accelerometer recordings. Muscle biopsies were taken from M Vastus Lateralis before and after the operation. **Results** A negative energy balance of 1,500-2,000 kcal/24 hours was estimated. Body weight declined 3.4 (95% CI 3.0-3.8) kg and muscle explosive strength, evaluated from squad and counter movement jumps, was reduced 5 and 6 %, respectively, after the operation with no difference between genders. Muscle glycogen content was reduced from  $269 \pm 58$  to  $181 \pm 44$  mmol/kg dry muscle ( $p < 0.05$ ) with no difference between genders. Muscle content of mTOR and p70 as well as MAFbx were unchanged while the protein content of MuRF-1 was significantly down regulated in both genders. **Discussion** The study indicated that prolonged low intensity exercise with substantial energy deficit reduces muscle function and muscle glycogen content. Proteins for muscle synthesis mTOR and p70 were unchanged while the down regulation of MuRF-1 indicates a protection against muscle break down during the energy deficit situation, preserving the muscle mass.

### INFLUENCE OF ANGIOTENSIN-CONVERTING ENZYME GENE I/D GENOTYPE AND REST INTERVAL BETWEEN SETS ON EXERCISE-INDUCED MUSCLE DAMAGE

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**Introduction** It is reported in the scientific literature that the insertion/deletion polymorphism of Angiotensin-converting enzyme gene (ACE) is associated to an increased susceptibility to Exercise-Induced Muscle Damage (EIMD), but there is no reports about the influence of the performance of resistance exercise with varied rest intervals between sets above susceptibility to the EIMD among subjects with different ACE gene genotypes. **Objective** The aim of this study is to evaluate the influence of I/D genotype of the ACE gene and the rest interval between sets, as well as, the interaction between these variables above the susceptibility to the EIMD. **Materials and Methods** Twenty seven healthy male performed two resistance exercise sessions one week apart. Exercise sessions consisted of 4 sets with 85% of 1 repetition maximum (1RM) for each exercise, which was carried out in the following order: bench press, lat pull down, shoulder press, elbow extension and elbow flexion. Each exercise was performed until the concentric failure and the rest interval between sets was randomly defined as 1 or 3 minutes for each session. Venous blood samples were taken previously and 24, 48 and 72 hours after each exercise session to measure the serum creatine kinase (CK) activity and to genotype subjects for ACE gene through the Polymerase Chain Reaction (PCR) technique, what allowed gathering the subjects according to the genotypes: II, ID and DD. The peak of serum CK activity, that is a muscle damage indicator, was used as dependent variable. The ANOVA two-way (3 genotypes x 2 rest intervals) was used to compare genotypes and exercise sessions with different rest intervals between sets, as well as the interactions between them. The  $p < 0.05$  significance level was adopted. **Results** There was significant difference in the serum CK peak between the genotypes ( $p = 0.041$ ), with bigger CK peak values in subjects with II genotype when compared to the others. There was not difference between the sessions with 1 and 3 minutes rest intervals ( $p = 0.863$ ). Similarly, there was not significant interaction between the genotypes and rest intervals to serum CK peak measurements ( $p = 0.969$ ). **Conclusion** The subjects with II genotype of the ACE gene are more susceptible to the EIMD, characteristic that is independent of the rest interval between sets adopted during resistive exercise sessions.

### FUNCTIONAL AND METABOLIC CHARACTERIZATION OF EXERCISING MUSCLE IN A MOUSE MODEL OF SICKLE CELL DISEASE

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**Introduction** Sickle cell disease (SCD) is an inherited disorder resulting in the synthesis of an abnormal hemoglobin (HbS) leading to painful vaso-occlusive crisis (VOC). Given that SCD is mainly considered as a hemoglobin and hemorheological disorder, its impacts at the muscle level have been scarcely studied. Yet, fatigue is a major symptom of the disease (Ameringer et al. 2013). Recent studies have disclosed a significant muscle remodeling in SCD indicating a potentially impaired supply and use of oxygen (Ravelojaona 2014). However, the metabolic translation of this remodeling process in exercising muscle is still unknown. The aim of this study is to characterize the potential functional and metabolic abnormalities in a mouse model of SCD. **Methods** Healthy (HbAA,  $n=11$ ), heterozygous (HbAS,  $n=10$ ) and sickle cell (HbSS,  $n=10$ ) mice were studied. The anesthetized mice were placed in a home-built device designed for a strictly non-invasive study of the gastrocnemius muscle by NMR (Giannesini et al. 2010). Information on muscle function, volume and metabolism were collected during a rest-stimulation-recovery protocol that was repeated twice 48 hours apart, for two exercise intensities (2 Hz and 0.5 Hz). **Results** On the contrary to the low-frequency protocol, HbSS mice displayed a reduced total force production (-46 and 25% compared to HbAA and HbAS, respectively) and a larger force reduction (-71  $\pm$  9%, -56  $\pm$  9% and -58  $\pm$  11% for HbSS, HbAA and HbAS, respectively) during the high-frequency protocol. At the metabolic level, HbSS mice exhibited a larger acidosis during the low- (+72 and 42% compared to HbAA and HbAS, respectively) and high-intensity protocols (+21% compared to HbAA and HbAS). **Discussion** We demonstrated in the present study that SCD was associated with an impaired muscle function and to a more pronounced exercise-induced intracellular acidosis. Both an increased non-oxidative glycolytic energy production and an altered protons handling might account for this larger acidosis. This alteration of muscle function and acidosis may represent degradation factors of quality of life (Ameringer et al.

2013) and a risk of triggering VOC (Ueda and Bookchin 1984) that could be deleterious for SCD patients. References Ameringer S, Elswick RK, Jr., Smith W (2013). *J Pediatr Oncol Nurs.* 31:6-17. Ravelojaona M. Thesis. Université Jean Monnet, 2014. Giannesini B, Vilmen C, Le Fur Y, Dalmasso C, Cozzone PJ, Bendahan D (2010). *Magn Reson Med.* 64:262-270. Ueda Y, Bookchin RM (1984). *J Lab Clin Med.* 104:146-159. Contact benjamin.chatel@live.fr

### EFFECT OF LONG-HAUL AIR TRAVEL EAST AND WEST ON RECOVERY OF TEAM SPORT PERFORMANCE.

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Introduction Though international travel is a requirement for elite team-sport athletes, limited information is available on the post-travel recovery timeline(1). Moreover, whilst it is proposed that jet-lag symptoms are worse following eastward compared to westward long-haul air travel(2), this is yet to be confirmed from relevant physical performance measures. Consequently, the present study determined the effects of eastward and westward long-haul air travel on physical performance relevant to team-sports. Methods Data was collected from 19 trained males at 09:00(AM) and 17:00(PM) for 4 days one week prior to (Baseline) and immediately following (Post 1-4) 21 h air travel west across eight time-zones from Australia to Qatar. Following a six day wash-out and 21 h return travel east, data was collected at the same times of day for a further four days (Post 1-4). Testing included a countermovement jump (CMJ), 20-m sprint and agility test, followed by the Yo-Yo Intermittent Recovery level 1 (YYIR1) test. Analyses were performed by fitting a linear mixed model to the absolute change from Baseline. Furthermore, standardised effect size (Cohen's d) analysis assessed the magnitude of differences between travel directions. Results CMJ peak power ( $P=0.01$ ;  $d=2.19$ ) and velocity ( $P=0.02$ ;  $d=1.91$ ) were lower at Post2 AM following westward compared to eastward travel. In addition, 5m sprint times were slower at Post2, 3 and 4 PM ( $P<0.05$ ;  $d>0.90$ ), 10m sprint times were slower at Post1, 3 and 4 PM ( $P<0.05$ ;  $d>0.90$ ), and 20m sprint times were slower at Post4 PM ( $P=0.01$ ;  $d=1.51$ ) following westward compared to eastward travel. Conversely, distance covered in the YYIR1 was significantly reduced at Post1 PM ( $P=0.01$ ;  $d=2.57$ ), and large effect sizes indicated reduced performance at Post2, 3 and 4 ( $d>1.00$ ) PM following eastward compared to westward travel. Discussion Long-haul transmeridian air travel can impair maximal lower-body power and intermittent-sprint performance for up to four days post-travel. Furthermore, a greater disruption of intermittent-sprint performance may occur following eastward compared to westward air travel. Conversely, westward air travel could have a greater impact on lower-body power. These contrasting results may relate to differences in arrival times and ensuing testing times. Thus, specific tailoring of recovery interventions may have merit based on travel direction and arrival time. Further research is required to articulate the specifics of such factors on team sport performance. References 1. Leatherwood et al. (2013) *Br J Sports Med*, 47(9):561-67. 2. Waterhouse et al. (2004) *J Sports Sci*, 22(10):946-965. Contact Rob.Duffield@uts.edu.au

## Oral presentations

### OP-BN07 Gender II

#### TECHNIQUE DIFFERENCES BETWEEN MALE AND FEMALE CROSS-COUNTRY SKIERS WHILE WHOLE BODY, UPPER BODY AND ARM POLING IN A SKI ERGOMETER

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Introduction: The anthropometric and physical differences between men and women should not only influence the capacity to generate power and energy, but may also lead to differences in technique in a whole-body endurance sport like cross-country skiing. Since the upper body plays a crucial role in this sport, specific training of the arms and trunk is of importance. However, little is presently known concerning gender differences in the technical execution of the double-poling movement and how this coincide with variations in exercise efficiency. Purpose: To characterize gender differences in the technical execution of upper body poling and exercise efficiency between whole-body (WP), upper-body (UP) and arm poling (AP) among elite cross-country skiers. Methods: Ten male and ten female elite cross-country skiers, matched for international performance level, completed three incremental submaximal tests and a 3-min all-out test on a Concept2 SkiErg in all poling modes. Power output was measured with the ergometer's internal software. Respiratory variables were assessed employing open-circuit indirect calorimetry. Movement data from eleven passive reflective markers on the ergometer and body was captured by the Qualisys motion capture system. The regression lines of submaximal oxygen uptake on power output were used to compare exercise efficiency. Results: When producing the 87% ( $152\pm 28$  vs  $285\pm 34$ W in WP), 97% ( $110\pm 19$  vs  $216\pm 34$ W in UP) and 103% ( $69\pm 12$  vs  $140\pm 20$ W in AP) higher power outputs during the 3-min test, men exhibited shorter poling times and used greater shoulder and elbow extension at the start of poling (all  $P<0.05$ ). There were no gender differences in the shoulder and elbow angles at the end of the poling phase. The hip angles did not differ between the men and women at the start of poling, but were significantly smaller for the men at the end of the poling phase, resulting in a larger trunk range of motion for the men (all  $P<0.05$ ). The relationship between oxygen uptake and power output during the three submaximal sessions did not differ between the men and women for any of the poling modes. Conclusions: The higher power outputs of the men coincided with significant gender variability in the technical execution of all poling modes and a favourable distribution of muscle mass in arms. The tendency towards greater angular range of motion of the trunk shoulder and elbow joints executed over relatively less time among men indicate a more explosive poling technique compared with female skiers. However, the energetic cost of a given power was independent of gender for all modes.

#### SEX DIFFERENCES IN COMPENSATION STRATEGIES FROM EXPERIMENTALLY REDUCED MUSCLE FUNCTION

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Females have greater incidence of traumatic knee joint injury compared to males [1]. Reduced muscle strength and varied activation patterns observed in females compared to males is suggested to contribute to the injury mechanism [2]. Yet it remains unclear if decreased stability is a direct result of the reduced muscle function or a more complex issue. Experimental reductions in quadriceps muscle function may provide more valuable insight into the effects of muscle weakness on joint stability. Young healthy adults (12 males, 10 females) participated in this study. Hypertonic saline (causing a perception of pain and a centrally mediated reduction in muscle activa-

tion [3]) was injected into VM of the dominant leg. Subjects performed 2 sets of 20 squats during 2 conditions: baseline and experimental pain. Kinematics, kinetics and surface EMG of 10 muscles were recorded. Squats were time normalized to 100%. Linear envelopes of the EMG were integrated for the descent and ascent phases (determined by peak knee flexion angles). Preliminary results are presented. Time to peak knee joint angle and joint flexion and extension velocities did not significantly differ between conditions (T-test  $p > 0.05$ ). Knee extension moment and power of the test leg was reduced with pain in both groups (-10.2% and -8.1%); however, only females demonstrated increased peak knee extension moments and power (+8.3% and 6.9%) in the contralateral limb. Integrated VM was reduced during both descent and ascent phases. Average peak VM activation was reduced by 43% in males and 40% in females. During ascent, a reduction in integrated vastus lateralis (VL) of both groups (~21%) and biceps femoris (BF) of females (~30%) was also observed. The hypertonic saline injections caused a reduction in voluntary muscle activation to both the VM and VL in males and females, thus reducing test leg knee extensor moments and power. However, a compensation strategy, evidenced by increased moment contribution in the contralateral limb, was only observed in females. Also, a reduction in vastii and hamstring activation was only observed in females which may decrease joint stiffness and increase the risk of anterior tibial translation and ACL strain [4]. Further investigation on muscle weakness and its effect on knee joint stability between sexes as well contributions from adjacent hip and ankle joints are warranted. References: [1] Gwinn et al, *Am J Sport Med* 28:98-102, 2000. [2] Hashemi et al, *Exp Mech* 47:347-354, 2007. [3] Graven-Nielsen, *Muscle Nerve* 26-63, 2002. [4] Fleming et al, *J Orthop Res* 19:1178-84, 2001.

### SEX DIFFERENCES IN MUSCLE ACTIVATIONS IN ASSOCIATION WITH ANTERIOR CRUCIATE LIGAMENT INJURY

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The incidence of knee injuries has been recorded to be as high as 4.6 times greater in females than in males [1] and the underlying cause for this disparity is still relatively unknown. Since muscles are the only active contributors to dynamic knee joint stability, it is quite feasible that the observed injury differences could be attributed to varying muscle activations between males and females. Therefore the objective of this study was to compare the muscle activations produced by males and females during countermovement jumps. This sub-study arises from a larger longitudinal study that tracks the functional ability of individuals who have torn their anterior cruciate ligament (ACL). To date, this sub-study consists of 10 healthy (5 male:  $30 \pm 8$ y; 5 female  $28 \pm 8$ y) and 10 ACL deficient (5 male:  $30 \pm 6$ y; 5 female  $28 \pm 6$ y) participants who completed three successful, two-footed countermovement jumps for maximum height. Trials were considered successful if the hands were kept on the hips, each foot landed entirely on a force plate, and balance was maintained. Linear envelopes were normalized to maximum voluntary isometric contractions and to 200 ms before and after foot contact at landing. Significant differences were tested using independent t-tests through statistical parametric mapping with a Bonferroni multiple comparisons correction for a final  $\alpha = 0.0125$ . In healthy young adults, all three (rectus femoris (RF), vastus medialis, and vastus lateralis) of the measured quadriceps muscles exhibited significantly greater activation in females pre-impact (0-20% of the cycle) than males. In ACL deficient, the RF was recruited more in males from the time of impact onwards ( $P = 0.001$ ) while the lateral gastrocnemius (LGAS) activation was greater in females than in males from 0-20% ( $P = 0.001$ ) and 40-80% ( $P = 0.000$ ) of the jump cycle. Timing of peak activation in the gastrocnemii showed no differences in the healthy controls, but after ACL rupture, female ACL deficient consistently took longer to reach their peak than healthy females in the LGAS ( $P = 0.001$ ) and significantly longer than male ACL deficient ( $P = 0.006$ ) and healthy females ( $P = 0.011$ ) in the medial gastrocnemius. The greater activation of quadriceps observed in healthy females than males pre-landing was not observed after ACL injury. Compared to injured males, injured females switched to a greater activation of the LGAS throughout a majority of the jump cycle and specifically at time of impact. At low flexion angles similar to those that occur at jump landing, the gastrocnemius acts as an antagonist to the ACL [2] due to the production of an anterior tibial shear force. Therefore, this higher LGAS activation at impact in females would generate a greater anterior shear force in an already unstable knee, which may contribute to the increased incidence of knee injuries seen in females. [1] Myklebust et al. *Scan J Med Sci Sports*, 8(3), 1998. [2] Fleming et al. *J Ortho Res*, 19(6), 2001.

### LEG DOMINANCE AND ACL INJURY RISK IN ELITE AUSTRALIAN FEMALE FOOTBALLERS

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Introduction: Leg dominance may be a possible aetiological risk factor in non-contact Anterior Cruciate Ligament (NC-ACL) injury. Female athletes, particularly in football (soccer), have a higher rate of ACL injury to their non-dominant leg (NDL). Muscles play an important role in stabilising the knee to prevent ACL injury. Therefore, this research examines leg dominance in the isokinetic strength of the knee flexors (KF) and knee extensors (KE) of elite female footballers. Methods: Fifty-five athletes were recruited from the elite Australian W League and national age football players ( $18 \pm 3$  yrs;  $59 \pm 8$  kg;  $165 \pm 8$  cm) without a history of knee injury. The dominant leg (DL) was the participants' preferred kicking leg. Knee muscle strength assessments were performed using multi-velocity isokinetic concentric and eccentric dynamometry. Results: Participants demonstrated differences in the joint angle at which peak torques were generated. NDL peak concentric KF torque was achieved at a greater flexion angle ( $47 \pm 13^\circ$ ) compared to the DL ( $39 \pm 15^\circ$ ) ( $p = 0.012$ ), where as peak NDL concentric KE torque was achieved at more extended knee angles ( $55 \pm 14^\circ$ ) than the DL ( $62 \pm 9^\circ$ ) ( $p = 0.002$ ). However, the participants demonstrated no differences between DL and NDL in peak torques, time to peak torque, rate of torque development and hamstring to quadriceps ratios. Discussion: This study demonstrated that leg dominance exists in female footballers though this may be difficult to identify using traditional isokinetic methodology and outputs. Importantly, contralateral differences exist in the joint angles at which peak KF and KE torques are generated. The results suggest quadriceps dominating the knee flexors at extended knee angles of the NDL compared to the DL. The quadriceps dominance, and the decreased ability of the KF to adequately resist rapid anterior shear forces, may be the reason for greater risk of NC-ACL injuries in the NDL of female athletes. This necessitates further research.

### SEX DIFFERENCES IN THE BIOMECHANICS OF BODYWEIGHT SINGLE-LEG SQUAT VARIATIONS

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Introduction Single-leg squats (SLS) are commonly used to make exercise recommendations and assess injury risk, but it is unknown whether the location of the elevated foot should be controlled to interpret performance. In a previous pilot study wherein a small sample

(N=12) of mostly men (N=10), we found that stance-leg net joint moment magnitudes did not differ within subjects who performed SLS with the elevated foot behind, beside, and in front of the planted foot (Chapman et al. 2014). Given that between-sex differences in SLS performance have been reported (Graci et al. 2012, Zeller et al. 2013), we were motivated to extend our initial pilot work to include a larger sample comprised of an equal number of men and women. Methods Thirty-two recreationally active volunteers who are injury- and pain-free have agreed to participate. Rigid clusters of markers will be attached to the feet, shanks, thighs, pelvis and trunk and three SLS variations (i.e., elevated foot front, side, back) will be performed. Marker positions will be recorded at 200 Hz, and ground reaction forces (GRFs) at 2000 Hz. Kinematic signals will be smoothed and input with the GRF data into an inverse dynamical linked-segment model of the body to yield body size-normalized estimates of the net joint sagittal and frontal moments about the hip, knee, and ankle. A general linear model ANOVA with one within- (SLS variation) and one between-subject (sex) factors will be used together with a least squares mean procedure to assess main/interaction effects. Biomechanical analyses will be completed using Visual3D, and statistical procedures will be conducted in SPSS. Results Data collection and analyses are currently in progress. Given previous research findings (Chapman et al. 2014, Graci et al. 2012, Zeller et al. 2013), we hypothesize that the position of the elevated foot during the SLS will not affect stance-leg net joint moment magnitudes within-subjects, but that these magnitudes will differ between men and women within SLS variations. References Chapman, C.J., Beach, T.A., Frost, D.M., Lonno, M., Escamilla, R.F., and Andrews, J.R. (2014) Biomechanics of Bodyweight Single-Leg Squat Variations: Implications for Movement Screening and Assessment. Proceedings of the 7th World Congress of Biomechanics. Boston, MA, USA. Graci V, Van Dillen LR, and Salsich GB. (2012). Gender differences in trunk, pelvis and lower limb kinematics during a single leg squat. *Gait & posture* 36: 461-466. Zeller, B.L., McCrory, J.L., Kibler, W.B., AND Uhl, T.L. (2003). Differences in kinematics and electromyographic activity between men and women during the single leg squat. *Am. J. Sports Med.* 33(3): p 449-456 Contact - Christopher Chapman: cchapman@csiontario.ca

### ENERGY EXCHANGE IN FEMALE POLE VAULT

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Introduction Pole vault is one of the most technical events in athletics, the knowledge of the mechanical energy exchange behind this event is essential to improve the performance of the athlete. It is already known the importance of run-up velocity and energy exchange in pole vault; however, some athletes' technical individualities directly affect the jumping mechanics. Thus, the aim of this study was to analyze the energy exchange during a female jump. Methods A female pole-vaulter (1.72 m, 57 kg) with a personal best of 4.85m took part in the study. The data acquisition was performed in the women's pole vault final at a national championship. Eleven jumps from 4.30 m to 4.91 m were recorded by 4 Basler (model A602fc) cameras synchronized (genlock) with a frequency of 100 Hz, positioned on the right side of the runway corridor. A 5 meters long rod was used for calibration. The video sequences here digitalized using the Dvideow system [1]. 3D coordinates of 18 points of interest were calculated by using the DLT method. The kinematic data were softened by 3rd order Butterworth digital filter with a cutoff frequency of 6 Hz for each one of the points of the model. The total energy of the athlete's center of mass (CM), over the time, was calculated as the sum of the potential energy plus kinetic energy. [2] Results Approach velocity had a CV 1.2%, with a takeoff average velocity of  $7.72 \text{ m/s} \pm 0.20 \text{ m/s}$ . The values of  $E_{\text{Initial}}$  and  $E_{\text{Final}}$ , were respectively  $45.96 \pm 0.82 \text{ J/kg}$  and  $47.14 \pm 0.71 \text{ J/Kg}$ . The variables of decrease and increase of energy were  $18.45 \pm 1.39 \text{ J / kg}$  and  $19.63 \pm 1.51 \text{ J / kg}$ . The gain of energy was  $1.18 \pm 0.83 \text{ J / kg}$ . The maximum height reached by the athlete's CM was significantly correlated with Final total energy ( $r = 0.82$ ,  $P < 0.01$ ). The athlete also has a higher grip position when compared with the best athletes in the world. Discussion Although the low values of  $E_{\text{gain}}$ , the athlete showed high values of  $E_{\text{Initial}}$  and  $E_{\text{Final}}$ ,  $45.96 \pm 0.82 \text{ J/kg}$  and  $47.14 \pm 0.71 \text{ J/Kg}$  respectively independent of the height jumped. Unlike other athletes, she has a higher Grip, which gives her an advantage over the other vaulters. This higher grip is due to the distinguished jump technique and it may be a good indicator of performance in pole vault as Angulo-Kinzler et al. (1994) observed in male athletes, confirming the findings in this study. When compared to the other vaulters she is one of the fastest with an average velocity of  $7.72 \text{ m/s} \pm 0.20 \text{ m/s}$ . The results of this study are relevant for women's pole vault improvement. References 1. Figueroa, P. J., Leite, N. J., Barros, R.M.L. (2003). *Computer Methods and Programs in Biomedicine*, 72, 155-165. 2. Arampatzis, A., Schade, F., and Brüggemann, G.-P. (1997). Pole vault. In H. Müller, and H. Hommel (Eds.), *New Studies in Athletics*. (Vol. 12), pp. 69-73 3. Angulo-Kinzler, R. M., Kinzler, S. B., Balius, X., Turro, C., Caubet, J. M., Escoda, J., et al. (1994). *Journal of Applied Biomechanics*, 10,147-165. Contact {fiagorussomanno@unb.br}

## Oral presentations

### OP-SH24 Sociology (Sport and gender)

#### "SPORTS DON'T LAST A LIFETIME, BUT I WANT TO LIVE WITH HIM FOREVER": FUNCTIONS AND DYSFUNCTIONS OF SEXUAL RELATIONSHIPS BETWEEN FEMALE ELITE-ATHLETES AND COACHES

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Introduction Coach-athlete sexual relationships (CASR) have been suggested to harm athlete welfare, sport performance, and to inherently constitute an abuse of power, trust and professional ethics by coaches (e.g. Brake & Burton Nelson, 2012; Toffegaard-Nielsen, 2001). However, very little is known about CASR, especially consensual romantic relationships between athletes and coaches of legal age (Johansson, 2013). The purpose with this research is to explore female elite-athletes' stories of CASR, emphasizing functional and dysfunctional aspects associated to athlete wellbeing and sport performance. Methods In-depth interviews included five female elite-athletes aged 23-30 with experience of CASR, i.e., boyfriend/girlfriend relationships and unattached sexual relations. Readings of interview transcripts and coding into functional and dysfunctional themes were conducted to generate the stories. Storying the athletes' experiences thus served to contextualise functions and dysfunctions on a within-case basis. Results The athlete's stories yield insights of qualitatively different functions and dysfunctions of CASR. Functional elements include specific components such as care, trust, sense of value and security, and a unique support and understanding. These elements were described to have a positive effect on the athletes' wellbeing and performance. Dysfunctional elements found in the athletes' stories comprised e.g., a need for secrecy in fear of negative reactions causing unhealthy restraints, career disruption due to break-ups and dependency tied to the partner/coach synthesis. Discussion

The diversity of functions and dysfunctions of CASR addressed in this study dispute the assumptions and normative notions that CASR are inherently harmful and abusive. The stories illustrate that female athletes can recognise consensual, mutually desired CASR. Importantly, functions and dysfunctions are not necessarily distinct, uniform or constant, but can transform and differ before, during and after the sexual relationship. This study emphasises the need to further examine how CASR can affect athlete wellbeing and sport performance in both functional and dysfunctional senses. References Brake D, Burton Nelson M (2012). *Staying in bounds*. Kansas City: National Association of Collegiate Women Athletic Administrators. Johansson S (2013). Coach–athlete sexual relationships: if no means no does yes mean yes? *Sport, Education and Society*, 18, 678–693. Toffegaard Nielsen J (2001). *The Forbidden Zone*. Intimacy, Sexual Relations and Misconduct in the Relationship between Coaches and Athletes. *International Review for the Sociology of Sport*, 36, 165–182. Contact susanne.johansson@gjh.se

### **SPORT AND PEACE BUILDING IN POST-CONFLICT SOCIETIES: THE ROLE OF OPEN FAN FOOTBALL SCHOOLS IN KOSOVO**

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**Abstract** The use of sports for purposes of development has been increasingly important topic particularly in post-conflict societies. However, there is a gap in the literature on how the sport can be used more productively as a peace building device in post conflict countries. This is because there is non-agreement in the literature on the role of sports in peace building. First, sport was viewed as mechanism to increase antagonism between rivalry groups and may reinforce division of ethnicities and second the sport could facilitate social inclusion and integration. This thesis uses qualitative research techniques mainly in-depth interviews with trainers, instructors and children in order to investigate how football sport in Kosovo contributed to peace building. In addition, the reflective practice technique was used because the author of the thesis has been involved in implementing Open Fan Football Schools (OFFS) in Kosovo. Based on findings the thesis argues that OFFS has played a vital role in peace building in Kosovo by bringing together and integrating different ethnicities in Kosovo. Findings also suggest that OFFS offer a hope for peace building and if adequately implemented can contribute to peace building in post-conflict societies similar to Kosovo. The study urges the need for more proactive policies and donor support to fund similar sport activities in order to promote peace building. **Keywords:** football, peace building, gender, post conflict countries, multi ethnicity. ert authors here

### **ZLATAN IBRAHIMOVIC – A POST-COLONIAL READ OF AN INDIVIDUAL SPORT TRADEMARK**

Johan, E.

*Malmö University*

**Zlatan Ibrahimovic – A post-colonial read of an individual sport trademark** Introduction In the beginning of October in 2014 a documentary telling the story of prominent Swedish football player Zlatan Ibrahimovic was released. Zlatan has lately taken a great interest in carefully nurturing his trademark with the topic of this piece being one of the latest additions. Just recently, however, Zlatan announced the campaign #805 million names in which he together with World Food Program intends to spread awareness of world hunger. The relevance of this piece, I argue, lays in Zlatan not only being the most published-of individual sport athlete in Sweden, as well as having fans all around the world, but also that he is a very special product of our time where the issues of race and xenophobia are as ever apparent. Method and theory With the documentary as empiricism this paper applies postcolonial theory in order to shed light on aspects which would have been difficult to otherwise acknowledge. In taking the theoretical steps provided by Frantz Fanon, Edward W.Said, Homi K. Bhabha and Gyatri Spivak this paper also attempts to perform what should be referred to as a postcolonial method. The mindset and thoughts provided by each of the above mentioned postcolonial theorists is used as a theoretical lens to reveal how the messages conveyed through the documentary might be analyzed and understood. Discussion Fanon's discussion of self/other is, when it comes to Zlatan, expressed in terms of being Swedish/being other, about him stating himself as different. The empiricism clearly demonstrates that being Swedish cannot be done without also being other. With Said, Zlatan is considered as the oriental in order to reveal the discourse that he, from a Saidian perspective, cannot distance himself from. In difference from Fanon, however, it becomes clear that the construction of other is occurring because of, and within, a discursive system, and that the self is constructed and strengthened by what it is not. It is the knowledge that produces the subject and the knowledge about the oriental and irrational Zlatan is found to be produced in order to find out how he can be what he is. With Bhabha, we will see how the stand initiated by Said (shifting the focus away from the other and turning the gaze on the self) gets expanded into a discussion of stereotypization and the ambivalence that follows. The problems which in this case initially were thought to be found in Zlatan (in Bhabha's case in the colonized) is in fact found in the opposite (the colonizer). The empiricism shows how the ambivalence makes the part in power unsure of where the borders of identity can be drawn. In the line with the Spivak way of thinking, Zlatans expressed collective subjectivity, and his wanted representation of everyone that is also different, is dissected through a discussion of subalternity.

### **ORGANISATION AND LEADERSHIP CHANGES REASONS FOR TEENAGE GIRLS TO DROP OUT FROM SPORT**

Eliasson, I., Johansson, A.

*Department of Education, Umeå university*

**Introduction** Many girls and boys quit sport in their teens and the reasons for this has eluded scientist and sport organisations for many years. This study was initiated by the Swedish Floorball Association with the aim to understand why many teenage girls quit floorball and to increase knowledge about what sport clubs can do to prevent girls from dropping out. A special research focus was directed towards the disengagement process which the girls undergoes when they take the decision to quit their sport. **Methods** The study is based on data from 24 semi-structured interviews with 12 girls aged 13-18 years (n=12) and with one parent from each of the girls (n=12). The girls belonged to three different floorball clubs geographically spread in Sweden and had quit floorball from 6 months to 2,5 years ago. The study draws on Ebaughs (1988) theory of the disengagement process. **Results** The results showed that the disengagement process can take from a few months up to two years before the girl takes the final decision to quit. The process was described by four different phases 1) First doubts 2) Seeking alternatives 3) The Turning point 4) After the decision. While the parents were involved in the process representatives from the sport clubs were almost absent. The longer into the process the girls where the more final their decision became. Six factors were identified as the main reasons for the girls to quit their sport, often a girl quit due to a combination of three to four of these factors. The most salient factors were an increased focus on sport performance and results, changes in the team's formation, new



coaches and changes in the coach attitudes, interest in other activities or sports, lack of time and high demands on themselves. No one of the girls in this study had been contacted from the sport organisations after they quit. Discussion The results point out the impact different changes had for the girls' decision to quit and the importance for the clubs to be aware of this. It also highlights how the absence of the representatives from the sport clubs in the girls' disengagement process led to limited knowledge about the girls' feelings and thought processes which means they were less able to adopt accurate strategies or to implement appropriate interventions to reduce the dropout rate. One message to the sport organisations is therefore to develop strategies for how to gather knowledge of their members' thoughts and feelings about their sport participation and be proactive in their work concerning how to handle changes, group cohesion and coach education. Organisation and leadership in the sport organisations were seen as key areas to develop when the ambition is to lower dropout rates. References Ebaugh, H., R., F. (1988). *Becoming an EX. The process of role exit*. Chicago: University of Chicago Press. Contact annika.johansson@umu.se, inger.eliasson@umu.se

## 10:20 - 11:50

### Invited symposia

#### IS-PM05 ROLE OF GLYCOGEN IN SKELETAL MUSCLE REGULATION AND FUNCTION

##### ROLE OF GLYCOGEN IN SKELETAL MUSCLE SR CA<sup>2+</sup> REGULATION

Ørtenblad, N.

*University of Southern Denmark*

**Introduction** Muscle glycogen is the preferential fuel during muscle work and the depletion of glycogen is thought to be a main contributor to muscle fatigue. Already in the beginning of the last century it was revealed that carbohydrate is an important fuel during exercise and pioneering muscle biopsy studies in the late 1960s, demonstrated that muscle glycogen contents is associated with exhaustion and that glycogen changes with exercise, recovery and training (1). Thus, the importance of skeletal muscle glycogen as a fuel during exercise, and fundamental aspects of glycogen regulation is well documented. However, little is known about the precise mechanism that relates skeletal muscle glycogen to impaired muscle function and cell signaling. The use of electron microscopy has revealed that glycogen is not homogeneously distributed in skeletal muscle fibres, but rather localized in 3 distinct pools: i) intermyofibrillar glycogen located between the myofibrils; ii) intramyofibrillar glycogen located within the myofibrils; and iii) subsarcolemmal glycogen located just beneath the surface membrane (3, 5). Further, each glycogen granule has its own metabolic machinery with glycolytic enzymes and regulating proteins. These glycogen granules are connected with the sarcoplasmic reticulum (SR) in close contact with key events in the excitation-contraction (E-C) coupling. In line with this, there has now been provided experimental evidence in favor of a direct role of decreased glycogen, localized within the myofibrils, for the reduction in SR Ca<sup>2+</sup> release during fatigue (2-5). This has been revealed at the level from isolated SR vesicles from human muscle after exercise and in single intact and mechanically skinned muscle fibres. Together, these results demonstrate that distinct subcellular populations of glycogen have different roles in contracting single muscle fibres and this may affect muscle contractility and fatigability. Such an SR-glycogen arrangement may involve a regulation of the cytosolic Ca<sup>2+</sup> levels and, in turn, the activation and energy utilization of skeletal muscle. References 1. Bergström J, Hermansen L, Hultman E & Saltin B (1967). *Acta Physiol*, 140-150. 2. Chin ER & Allen DG (1997). *J Physiol* 498, 17-29. 3. Nielsen N & Ørtenblad N (2013). *Appl Physiol Nutr Metab* 38, 91-99. 4. Nielsen J, Cheng AJ, Ørtenblad N and Westerblad H. (2014). *J Physiol* 592(9): 2003-12. 5. Ørtenblad N, Nielsen J, Saltin B & Holmberg HC (2011). *J Physiol* 589, 711-725. Contact nortenblad@health.sdu.dk

##### SINGLE MUSCLE FIBRE ANALYSIS OF PROTEINS IMPORTANT FOR GLYCOGEN METABOLISM IN SKELETAL MUSCLE FROM TRAINED CYCLISTS FOLLOWING HIGH-INTENSITY AND AEROBIC-INTENSITY BOUTS OF EXERCISE.

Murphy, R.1, Frankish, B.1, Lane, S.2, Areta, J.2, Stapleton, D.3, Hawley, J.1

*(1) La Trobe University, (2) RMIT University, (3) The University of Melbourne*

**INTRODUCTION** Glycogen is an important fuel source, providing energy for contracting skeletal muscle. Skeletal muscle is heterogeneous in nature, comprised of slow-twitch (Type I) and fast-twitch (Type II) fibres, which are distinct in their metabolic and contractile properties. This study investigated the effects of varying glycogen availability by utilizing different exercise modes in humans. We measured the abundance of specific glycogen related proteins as well as their phosphorylation (activation) state where applicable. Uniquely, we determined these changes in individual fibres, thereby addressing muscle heterogeneity. **METHODS** Eight endurance-trained cyclists performed two experimental trials (Low or High glycogen), where glycogen content was manipulated via exercise-diet interventions. Each experimental trial lasted 15 hours, consisting of a high-intensity interval training (HIT, evening of day 1) and aerobic-intensity training (AIT, morning of day 2) bout of exercise. Muscle biopsies from the vastus lateralis were collected Pre- and Post- each exercise bout and individual muscle fibres were immediately collected under paraffin oil, and prepared for western blotting analysis. **RESULTS** Overall, following the HIT bout of exercise, there were fibre type- and trial-specific decreases in glycogen synthase and glycogen phosphorylase, with concomitant increases in their phosphorylated forms. No changes in glycogen branching or glycogen debranching enzymes were seen following HIT in either trial. AIT did not result in any changes seen for those proteins in either the Low or High glycogen trials. **DISCUSSION AND CONCLUSIONS** Glycogen availability influences the expression of various glycogen related proteins, and does so in a fibre specific manner. These findings highlight the complexity of glycogen metabolism and that fibre type needs to be considered when understanding its regulation. Analyses conducted in whole muscle should therefore be interpreted with caution.

##### INTRACELLULAR COMPARTMENTALIZATION AS A REGULATOR OF GLYCOGEN METABOLISM AND INSULIN SIGNALING

Prats, C.

*Core Facility for Integrated Microscopy, Center for Healthy Aging, University of Copenhagen*

During the last decades, visualization of the intracellular dynamics of metabolic events has revealed a key player in the regulation of signalling and metabolic pathways, compartmentalization. Cells are not bags full of metabolites and enzymes, the complexity and the

dynamics of intracellular compartments are finely designed and modulated to host specific cellular processes and regulate them. Several steps in glycogen metabolism and insulin signaling are regulated by intracellular redistribution of key enzymes and local accumulation of metabolites. Furthermore, several studies have reported evidence that indicate that glycogen metabolism is locally regulated; where intermyofibrillar and intramyofibrillar glycogen particles are differentially utilized to fulfill specific energy demands. Here, I will review and summarize what is known and what is still lacking to reach full understanding of the complexity of skeletal muscle glycogen metabolism and insulin signaling.

## Invited symposia

### IS-PM14 EFFECT OF SCHOOL BASED PHYSICAL ACTIVITY INTERVENTIONS

#### TWO DANISH SCHOOL-BASED PHYSICAL ACTIVITY INTERVENTIONS

Bugge, A., Klakk, H., Wedderkopp, N., Andersen, L.B.

*University of Southern Denmark*

Introduction Schools are potentially effective settings for early public health prevention. The aim of these two studies was to evaluate the effect of additional physical education (PE) lessons in Danish public schools on cardiovascular disease (CVD) risk and body composition. Methods The two quasi experimental studies were; The Copenhagen School Child Intervention Study (CoSCIS) (1) and The Childhood Health, Activity and Motor Performance School Study Denmark (CHAMPS) (2). The increase in PE was two extra lessons in CoSCIS and four extra PE lessons in CHAMPS, both compared to the mandatory two PE lessons in the control schools. CoSCIS involved 18 schools (10 intervention and 8 controls) and included a post-intervention measurement three years after the onset of the intervention and a follow-up four years after the end of intervention. The analyses included 696, 6- to 7-year-old children at baseline. CHAMPS involved 10 public schools (6 intervention and 4 control). Analyses included 1218 children, aged 6–10 years at baseline and here we include the two-year follow-up. Anthropometrics, systolic blood pressure (SBP) and aerobic fitness was measured at baseline and follow up in both studies. Fasting blood samples were analyzed for classic CVD risk factors and a composite risk score was computed from z-scores of CVD risk factors. Results In CoSCIS the intervention did not have a positive effect on the composite risk score or measures of body composition either at post-intervention or the follow-up. The HOMA score of the intervention group boys had a smaller increase from baseline to post-intervention compared with control boys ( $p = 0.004$ ). From baseline to follow-up intervention group boys had a smaller increase in SBP compared with control boys ( $p = 0.010$ ). There were no other significant differences between groups. In CHAMPS the intervention significantly lowered mean of composite risk score with 0.17 SD (95% CI:  $-0.34$  to  $-0.01$ ). Six PE lessons per week had a beneficial effect on triglycerides levels ( $-0.18$  SD, 95% CI:  $-0.36$  to  $0.00$ ), systolic blood pressure ( $-0.22$  SD, 95% CI:  $-0.42$  to  $-0.02$ ) and insulin resistance (HOMA-IR) ( $-0.17$  SD, 95% CI:  $-0.34$  to  $0.01$ ). The intervention did not result in any effects on mean value of BMI. However, a beneficial intervention effect on prevalence of OW/OB based on BMI (OR 0.29, 95% CI: 0.11 to 0.72) was found. Discussion Based in these two studies, there seem to be a threshold for the amount of extra physical activity in school-based interventions to affect CVD risk profile and body composition. Further studies are needed to verify this. References 1. Bugge, A., B.El-Naaman, M.Dencker, K.Froberg, I.M.Holme, R.G.McMurray, and L.B.Andersen. 2012. Effects of a 3-year intervention: The Copenhagen School Child Intervention Study. *Med.Sci Sports Exerc.* 2. Klakk, H., L.B.Andersen, M.Heidemann, N.C.Moller, and N.Wedderkopp. 2014. Six physical education lessons a week can reduce cardiovascular risk in school children aged 6-13 years: a longitudinal study. *Scand.J.Public Health* 42:128-136.

#### EFFECTS OF A 2-YEAR SCHOOL-BASED DAILY PHYSICAL ACTIVITY INTERVENTION. THE SOGNDAL SCHOOL-INTERVENTION STUDY.

Resaland, G.K., Anderssen, S.A., Andersen, L.B.

*Sogn and Fjordane University College*

Introduction We aim to present parameters of importance to achieve health-improving effects on fitness and cardiovascular risk factors based on a two-year school-based teacher-led 60-minute daily physical activity intervention school that took place over two academic years. Methods A total of 259 children, corresponding to all fourth-graders enrolled in 2004 (born 1995) and 2005 (born 1996) in two elementary schools in two rural municipalities in Western Norway, were invited to participate. Intervention-school children ( $n = 125$ ) carried out 60-minute daily physical activity over two school years. Control-school children ( $n = 131$ ) had 45 minutes of physical education twice weekly. We analyzed serum glucose, insulin, total cholesterol, high density lipoprotein cholesterol and triglyceride. Peak oxygen uptake was directly measured during a treadmill protocol. Also body mass, height, weight, blood pressure and waist circumference were measured. Results We found a significant greater beneficial development in cardiorespiratory fitness, blood pressure, total cholesterol to high-density lipoprotein cholesterol ratio and triglyceride in intervention-school children than in control-school children. Those children in the Intervention-school with the least favorable starting point experienced the most beneficial effect of the intervention. Conclusion In conclusion, a school-based physical activity intervention can beneficially modify children's CVD risk profile if the intervention is of sufficient length and if the physical activity is planned, organized and led by expert physical education teachers. Therefore, this intervention has shown that physical activity can positively modify fitness and cardiovascular risk factors at an early age, and thus might be an important tool in the primary prevention of cardiovascular diseases, and should be given due consideration in the design of school policies. The Intervention school has decided to continue its commitment to the physical activity program, and expand the program to all 330 pupils. The program consists of 30 minutes of daily teacher-led physical activity. Also other schools in the area have established physical activity as part of the school curriculum.

#### EFFECTS OF SCHOOL-BASED PHYSICAL ACTIVITY INTERVENTIONS: THE KISS STUDY

Kriemler, S.1, Zahner, L.2, Meyer, U.3

*1;3University of Zürich; 2University of Basel*

Introduction We aim to present parameters of importance to achieve health-improving effects on physical activity level, fitness and cardiovascular risk factors based on a physical activity intervention in elementary school that took place over one academic year and with a follow-up 3 years off intervention. Methods Twenty-eight classes from two of 26 provinces in Switzerland were cluster randomized to the

intervention (16 classes, n=297) and control (12 classes, n=205) groups. The intervention consisted of a multi-component PA intervention including daily physical education, short activity breaks, and education of classroom teachers. Primary outcomes included body fat (skin-fold thickness), aerobic fitness (shuttle run test), PA (accelerometry), and quality of life (questionnaires), secondary outcomes included a composite cardiovascular risk score (blood samples). Children and parents in the control group were not aware of the existence of an intervention group. Results Of 502 children, 498 provided baseline and post-intervention data and 58% of those who took part at baseline participated at the follow-up 3 years off intervention. At post-intervention, children in the intervention compared to the control group showed statistically significant decreases in the sum of four skinfolds (adjusted difference (AD) -2.10mm; 95%-CI -3.48 to -0.90), and significant improvements in aerobic fitness z-score (AD 0.22; 95CI 0.01 to 0.42), MVPA at school (AD 1.19 z-score units; 95CI 0.78 to 1.60) and over the day (0.44 z-score units; 95CI 0.04 to 0.82), corresponding to 11-14 min of differences among groups per day, and a more favourable composite cardiovascular risk score (AD -0.18; 95CI -0.29 to -0.06). Quality of life and total PA did not change. At the 3-year follow-up, children in the intervention arm compared with controls had a significantly higher aerobic fitness (AD 0.373 z-score units; 95CI 0.157 to 0.59) corresponding to a shift from the 50th to the 65th percentile between baseline and follow-up, while the immediate beneficial effects on the other primary outcomes were not sustained. In conclusion, body composition, aerobic fitness, moderate-vigorous PA in school, and cardiovascular risk factors can be significantly improved in primary school children by a multi-component PA intervention, provided by experts and with compulsory elements within one school year. However, a continuous intervention or an adaptation of our school system with the provision of daily PE taught preferably by experts seems necessary to maintain overall beneficial health effects as reached at the end of the intervention.

## Invited symposia

### IS-PM07 LIFELONG ENDURANCE TRAINING: MAINTENANCE OF HIGH CARDIOVASCULAR AND OXIDATIVE METABOLIC PERFORMANCE WITH AGING: IN HONOUR OF BENGT SALTIN \*

#### LONGITUDINAL PUMPING IS PRESERVED WITH LIFELONG ENDURANCE TRAINING AND IS AN INDEPENDENT PREDICTOR OF MAXIMAL CARDIAC OUTPUT

Steding-Ehrenborg, K., Boushel, R.C., Calbet, J.A., Åkeson, P., Mortensen, S., Saltin, B.  
*Copenhagen Muscle Research Centre, Denmark and Hvidovre Hospital, Denmark*

Background: Ageing decreases cardiac volumes and function, and lifelong endurance training has been shown to prevent or postpone some of the deteriorations. The effects of normal ageing as well as of lifelong endurance exercise on longitudinal and radial contribution to stroke volume are unknown. The aim of this study was to determine longitudinal and radial pumping at rest in healthy untrained and well trained elderly. Furthermore, we aimed to investigate the relationship between cardiac output during maximal exercise and longitudinal and radial pumping. Methods: Eight male elderly athletes (age 63±4 years) and seven matched control subjects (age 66±4 years) underwent cardiac magnetic resonance imaging (CMR). Athletes and controls also underwent maximal exercise testing to determine peak oxygen uptake (VO<sub>2</sub>peak) and exercise cardiac output was determined using dye dilution technique. Results: Left ventricular longitudinal and right ventricular longitudinal contribution to stroke volume (%) was higher in athletes compared to controls (65±13% vs 52±13%, p=0.06 and 87±13% vs 78±11%, p=0.13, respectively). Radial contribution (%) was similar in both athletes and sedentary controls (8.1±1.8% in athletes, 8.6±1.4% in controls, p=1.0). Left ventricular atrio-ventricular plane displacement was an independent predictor of maximal CO (R<sup>2</sup>=0.89, p<0.0001, β=0.89). Conclusion: Elderly athletes have preserved longitudinal function at a level similar to young untrained subjects. Longitudinal function is the main contributor to ventricular ejection and is an important factor to achieve a cardiac output that meets the increased metabolic demands with increased activity and exercise.

#### ENDOTHELIAL-MEDIATED VASODILATION AND MUSCLE VASCULAR CONDUCTANCE DURING EXERCISE

Mortensen, S.P.  
*University of Southern Denmark*

Exercise training is known to alter the responsiveness and capacity of the vasculature to dilate in response to vasodilator stimuli including signals induced during muscle contraction. In this talk, the influence of lifelong physical activity on vascular function will be presented. Blood flow responses to femoral arterial infusion of dilator substances will be compared between lifelong trained elderly and sedentary young and older individuals. These responses will be related to the vascular conductance responses during exercise involving a small and large muscle mass measured together with arterial and venous blood pressures. The role of local vasodilator signals for regulating muscle vasodilatation will be integrated with measures of tonic regulation of blood flow by vasoconstrictor signals from the sympathetic nervous system in contracting muscle and in inactive vascular beds. The interplay between local mediators of muscle vasodilatation such as ATP, adenosine, nitric oxide and prostacyclin and their sympatholytic influence in the control of muscle blood flow with lifelong physical activity will be discussed.

#### LIFELONG TRAINING KEEPS MITOCHONDRIA YOUNG

Boushel, R.  
*The Swedish School of Sport and Health Sciences*

Ageing is associated with diminished cardiovascular function, and loss of muscle oxidative capacity is also considered a salient feature. While moderate-to-high intensity training increases O<sub>2</sub> delivery to muscle and induces mitochondrial biogenesis, it remains unclear to what extent ageing in itself, or a lower training level with age contributes to loss of skeletal muscle oxidative capacity. Leg O<sub>2</sub> delivery and VO<sub>2</sub> were determined during incremental exercise on a cycle ergometer in 8 men (67±2 yrs) who maintained road cycle training >200 km/week for >40 years (Lifelong-Trained -LT) and compared to age-matched sedentary (UT) controls (67±1 yrs). Mitochondrial respiratory capacity was measured in permeabilized fibres from biopsies of the quadriceps using respirometry (Oxygraph, Oroboros, AT). Peak VO<sub>2</sub> across the legs measured by the Fick method was 36% higher in LT (2693±186 ml.min<sup>-1</sup>) compared to UT (1981±166 ml.min<sup>-1</sup>) with a 12% higher leg O<sub>2</sub> extraction in LT. V<sub>max</sub> of mitochondrial respiration with mixed substrates was ~2-fold higher in the ET (109±6 pmol.sec<sup>-1</sup>.mg<sup>-1</sup>) compared to UT (60±4 pmol.sec<sup>-1</sup>.mg<sup>-1</sup>, p<0.01). Excess capacity of mitochondria over O<sub>2</sub> delivery was larger in the LT compared

to UT resulting in lower relative ADP activation of mitochondria in-vivo at peak exercise, accompanied by a lower in-vivo mitochondrial p50. The findings reveal that skeletal muscle mitochondrial respiratory capacity of lifelong trained males is retained at a level comparable to trained young individuals, and indicate that decrements in aerobic performance with age are primarily attributed to diminished oxygen delivery.

### **CENTRAL HAEMODYNAMICS DURING EXERCISE**

Calbet, J.A.

*University of Las Palmas de Gran Canaria*

Maximal oxygen uptake (VO<sub>2</sub>max) is the main determinant of the exercise capacity and is a good predictor of life expectancy. VO<sub>2</sub>max is progressively reduced with ageing. Since VO<sub>2</sub>max is primarily determined by maximal oxygen delivery and secondary by the muscular capacity to extract oxygen, the factors determining maximal oxygen delivery become critically important to understand how exercise capacity is limited with ageing. Maximal systemic oxygen delivery depends on maximal cardiac output (Q<sub>max</sub>) and arterial oxygen content. Q<sub>max</sub> explains most of the reduction in VO<sub>2</sub>max with ageing. However, the limiting role of Q<sub>max</sub> has been reported to be more important in trained than in untrained elders. This could indicate that other factors apart from maximal systemic oxygen delivery may have a greater role in untrained elders. For example, it has been reported that peak leg blood flow (LBF<sub>peak</sub>) during upright whole body exercise is reduced with ageing. However it remains unknown whether the reduction of the maximal muscular perfusion is proportionally greater than the reduction of Q<sub>max</sub> due to reduced vascular conductance. Moreover, it remains unknown what factor limits VO<sub>2</sub>max in world level elite endurance elderly athletes. Here we present central and peripheral haemodynamic data obtained in 6 young (Y) (21±2 years), 8 lifelong sedentary elderly (LSE) (66±5 years) and 4 elite endurance elderly athletes (EEA) (65±6 years) men during incremental cycling to exhaustion. EEA achieved a greater VO<sub>2</sub>max than LSE, due to higher cardiac output (+45-55%) explained by a much higher stroke volume in EEA than Y and LSE. Peak leg blood flow (LBF<sub>peak</sub>) was 25% lower in LSE than in Y and 48% higher in EEA than in LSE. Thus, ageing is associated with reduced Q<sub>max</sub> and LBF<sub>peak</sub>, while lifelong participation in elite endurance events maintains LBF<sub>peak</sub> at levels similar to those observed in young sedentary men. The remarkably higher Q<sub>max</sub> in EEA than Y or LSE (25±3, 21±2, 19±2 L/min, respectively) is associated to a higher central blood volume and preload at W<sub>max</sub> in EEA, for a similar afterload in the three groups. The main reason why LBF<sub>peak</sub> is reduced with ageing appears to be the reduction of Q<sub>max</sub>, since the three groups directed a similar amount of blood flow to perfuse the trunk. Supported by the Lundbeck Foundation and Augustinus Foundation

### **Invited symposia**

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### **IS-PM15 RECENT DEVELOPMENTS IN ALTITUDE AND HYPOXIC TRAINING SPONSORED BY ASPETAR**

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#### **DOES ALTITUDE TRAINING ACTUALLY IMPROVE ENDURANCE PERFORMANCE IN ATHLETES? A CRITICAL REVIEW OF THE DIFFERENT METHODS**

Robach, P.

*Ecole Nationale des Sports de Montagne, site de l'Ecole Nationale de Ski et d'Alpinisme*

Endurance athletes often use altitude training in an attempt to enhance exercise performance. Evidence suggests that altitude training may be useful for some athletes, and the accepted underlying mechanism is an increase in total hemoglobin mass and thus oxygen carrying capacity. However, a crucial question remains unanswered: is altitude training beneficial for endurance champions? The traditional Live high – train high (LHTH) method is somewhat “paradoxical” since 1) controlled studies failed to demonstrate any clear impact on physical performance in highly-trained individuals, but 2) LHTH remains the most popular altitude-training method, likely due to numerous anecdotal reports from world-class athletes showing outstanding competitive results following LHTH. Here the gap between science and practice highlights the need for further research on highly-trained individuals. The effectiveness of Live high – train low (LHTL) on exercise performance was demonstrated in well-trained individuals using natural altitude. Insights from LHTL using simulated altitude show marginal performance improvement in highly-trained individuals, suggesting that the effectiveness of this method in athletes with high total hemoglobin mass and maximal oxygen uptake is limited. It may be that LHTL using hypobaric hypoxia does promote stronger adaptive responses and therefore performance enhancement, however this hypothesis must be further verified. Live low – train high (LLTH), i.e. hypoxic training, yields conflicting results in untrained and trained individuals, suggesting no consistent advantage for sea-level performance for elite athletes in particular. It may be that high-intensity interval training or even repeated sprint-training coupled with hypoxia has a positive effect on performance. Whether this benefit extends to elite athletes is however unclear. In summary, altitude training methods based on hematological changes (LHTH and LHTL) seem more certain than those based on within skeletal muscle changes (LLTH). Living and/or training in a natural hypoxic environment might be the best option for elite endurance athletes, both with respect to adaptive responses and motivational aspects. More controlled studies investigating highly-trained individuals are necessary.

#### **SANGUINE ALTITUDE – OVERLY OPTIMISTIC OR DOES THE EVIDENCE STACK UP?**

Gore, C.

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Introduction Altitude/hypoxic training remains popular despite the challenge of demonstrating performance advantage (3). There are a variety of hypoxic modalities used ranging from living and training at altitude (live high:train high - LHTH) (8), to live high:train low (LHTL) (8), live low:train high (10) and resting in hypoxia (12). Despite encouraging results for several of these modalities to increase haemoglobin mass (Hbmass), the associated logistics has caused a search more time efficient protocols, which may be less disruptive to training and competition (2; 10). My aim is to review data for (Hbmass) to identify the minimum useful dose. Discussion Critical to interpreting changes in Hbmass is minimising sources of error associated with the technique, therefore I will review data to quantify the imprecision of Hbmass and how to minimise it. Estimates of within subject standard deviation of Hbmass derived ~10 years apart indicate a value of ~2% (4; 5). Two recent meta-analyses (5; 11) will be used to attempt to answer the questions of “How high and how long is required to increase Hbmass”, “What is the minimum time-effective dose?”, “How long do the effects last?”, and “Will altitude training work for me?”. Confounders that can blunt an increase in Hbmass at altitude include illness (9), negative energy balance (9) and lack of iron. The latter

will be explored in terms of a retrospective analysis of the dose of oral iron relative to ferritin iron stores (7). Despite there being a clear relationship between increased Hbmass and VO<sub>2</sub>max (14), the strength of this relationship in athletes after altitude training is less clear, with an ~1% increase in Hbmass resulting in a 0.6–0.7% increase in VO<sub>2</sub>max (13). A meta-analysis of natural altitude interventions concludes that the mean performance benefits are of the order of 2–4% among elite athletes (1), but this is not always the case in athletes despite increased Hbmass (6). In conclusion, LHTH and LHTL altitude training is likely worthwhile but there are often many mitigating factors to overcome. References 1. Bonetti DL & Hopkins WG. *Sports Med* 39:107-27, 2009. 2. Garvican-Lewis LA, et al. *Br J Sports Med* 47 Suppl 1:i70-i73, 2013. 3. Gore CJ. *J Appl Physiol* 116:593-94, 2014. 4. Gore CJ et al *J Appl Physiol* 99: 1745-58, 2005. 5. Gore CJ et al *Br J Sports Med* 47: i31-i39, 2013. 6. Gough CE et al *Eur J Appl Physiol* 112: 3275-85, 2012. 7. Govus AD, et al *PLOS ONE* In review. 8. Levine BD & Stray-Gundersen J. *J Appl Physiol* 83:102-12, 1997. 9. Mclean BD et al *Br J Sports Med* 47:i51-i58, 2013. 10. Mclean BD et al *Sports Med* 44: 1275-87, 2014. 11. Rasmussen P, et al. *Med Sci Sports Exerc* 45:1767-72, 2013. 12. Rodriguez FA et al *J Appl Physiol* 103:1523-35, 2007. 13. Saunders PU et al *Br J Sports Med* 47:i26-i30, 2013. 14. Schmidt W & Prommer N. *Scand J Med Sci Sports* 18 Suppl 1: 57-69, 2008. Contact chris.gore@ausport.gov.au

## **INNOVATIONS IN HYPOXIC TRAINING TO MAXIMIZE PHYSICAL PERFORMANCE: FROM ENDURANCE ATHLETES...TO TEAM-SPORT PLAYERS...TOWARD PATIENTS**

Millet, G.

*University of Lausanne*

Twenty years ago, the main altitude training method used was "live high - train high" (LHTH) [1] in hypobaric hypoxia by endurance athletes. It was modified mid-90s by the development of "live high - train low" (LHTL) [2]; sleeping at altitude to gain the hematologic adaptations (Hbmass) while training at sea level to maximize performance (maintenance of sea level training intensity). This LHTL method can be accomplished via a number of methods and devices: natural/terrestrial altitude (HH) or in "simulated altitude" (normobaric hypoxia, NH) using nitrogen dilution or oxygen filtration [3]. Another hypoxic intervention is "live low - train high" (LLTH) mainly in NH, including intermittent hypoxic exposure at rest (IHE) or during intermittent hypoxic training sessions (IHT). Noteworthy, most of the available studies were conducted with endurance athletes. Recently, our research group challenged two points (1) that normobaric and hypobaric hypoxia can be used interchangeably, both in medicine and in sport (2) that altitude training benefits are limited to Hbmass and to aerobic sports. 1. Based on the existing data [4] relating to differences in ventilatory responses, fluid balance, acute mountain sickness severity and/or nitric oxide metabolism, it is likely that HH induces different physiological responses than NH. Recently, we reported that both 24 h [5] and 18 days [6] of LHTL in either NH or HH differentially affect oxidative status of athletes. Furthermore, Saugy et al. [7] reported that LHTL (2250 – 1100 m) while sleeping in HH versus NH induced different responses and a larger performance enhancement. Sleeping pattern also differs between NH and HH [8]. 2. Recently, we [9-11] defined a new hypoxic method (RSH, repeated sprint training in hypoxia) leading to improved repeated-sprint ability (RSA). Therefore, we logically proposed [9] to divide the LLTH paradigm in four subsets; i.e. IHE, CHT (continuous training in hypoxia), IHT and RSH since each method is likely based on different mechanisms. Faiss et al. showed larger improvements in cycling [12] or cross-country skiing [13] RSA following few (6-8) RSH sessions compared to similar training in normoxia. Finally, Brocherie et al. [14] reported that in elite team-sport players, the combination of LHTL and RSH ("live high train low and high", LHTLH) enhances both Hbmass and RSA. 1. Mellerowicz H. *Schweiz Zeitschrift Sportmed* 1971:Suppl:5-17 2. Levine BD. *J Appl Physiol* 1997;83(1):102-12 3. Millet GP. *Sports Med* 2010;40(1):1-25 4. Millet GP. *J Appl Physiol* 2012;112(10):1783-4 5. Faiss R. *Med Sci Sports Exerc* 2013;45(2):253-60 6. Debevec. 2015; In review 7. Saugy. *PLoS One* 2014;9(12):e114418 8. Heinzer R. *Sleep Med* 2013;14(Suppl 1):e285 9. Millet GP. *Br J Sports Med* 2013;47 Suppl 1:i6-i7 10. Faiss R. *Br J Sports Med* 2013;47 Suppl 1:i45-i50 11. Brocherie F. *J Strength Cond Res* 2015;29(1):226-37 12. Faiss R. *PLoS One* 2013;8(2):e56522 13. Faiss R. *Med Sci Sports Exerc* 2015; in press 14. Brocherie F. *Med Sci Sports Exerc* 2015; in press

## **Invited symposia**

### **IS-BN08 MENTAL AND COGNITIVE TRAINING: IMPORTANCE FOR SKILL LEARNING, REHABILITATION AND SPORTS ACTIVITIES– MECHANISMS AND APPLICATIONS**

#### **MENTAL TRAINING OF FINE MOTOR SKILLS**

Leukel, C., Lauber, B., Kurz, A., Niemann, N., Gollhofer, A., Taube, W.

*University of Freiburg*

Fine motor skills are unique in humans compared to other species (Porter R and RN Lemon 1993). They are relevant in everyday life as well as in sports (e.g. dart throwing, shooting, basketball shots, etc.) and great effort is made to rehabilitate these functions in case of an injury. Therefore, new approaches seek to find better ways to effectively train these functions. In this context, we recently performed experiments asking whether mental training is able to improve motor performance. We concentrated on two types of fine motor skills, movement accuracy and movement speed (Lundbye-Jensen J et al. 2011). Furthermore, as subsequent training of both types was shown to cause interference (i.e. the performance improvements of one skill is reduced by subsequent training of the other skill) (Lundbye-Jensen J et al. 2011; Lauber B et al. 2013) we asked whether mental training would prevent interference. The present talk therefore addresses how fine motor skills, but not ballistic contractions, can be improved by mental training and how mental training may prevent interference. Some of the underlying neural principles will be presented and the potential consequences of these findings for training interventions are discussed. Lauber et al. 2013. *PLoS ONE* Lundbye-Jensen. *PLoS ONE* Porter R, Lemon RN. 1993. *Monographs of the Physiological Society*, No. 45. New York: Oxford University Press.

#### **IMPACT OF COMPUTERIZED COGNITIVE TRAINING DURING PERIODS OF INACTIVITY**

Marusic, U.

*University of Primorska*

The talk will briefly present the effects of prolonged inactivity (immobilization) on the human body such as impaired cardio-vascular, skeletal and muscular systems (Pavy-Le Traon et al., 2007) with additional evidence of potential deficits in sensorimotor functioning (Car-

penner et al., 2010), cognition (Lipnicki & Gunga, 2009) and brain functioning (Marusic et al., 2014). Several studies have shown the close interrelation of physical activity and cognitive function (Kramer & Erickson, 2007). This talk will briefly present the efficacy of cognitive interventions for the enhancement of sports performance and highlight the importance of developing new interventions for staying cognitively active during physical inactivity in order to maintain sensorimotor function. For this purpose, studies targeting and improving specific cognitive domains will be presented (Tardif & Simard, 2011). Verghese et al. (2010) have demonstrated that cognitive training can even lead to improved mobility performance in sedentary seniors due to a close link between these areas of cognition and motor control. To illustrate this close link, we will present behavioral adaptations in gait parameters as well as neural adaptations assessed by multichannel EEG. Furthermore, the importance and effectiveness of cognitive training in a virtual environment (targeting spatial navigation, executive functions, working memory and attention) while being physical inactive will be highlighted and effects after 28-days of rehabilitation and after 400-days after completion of rehabilitation will be presented.

### **EFFECT OF MOTOR IMAGERY AND MOVEMENT OBSERVATION ON POSTURAL CONTROL AND SENSORIMOTOR FUNCTION OF THE CERVICAL SPINE**

Taube, W.

*University of Freiburg*

Studies indicate that motor imagery (Hallett et al. 1994) and observation of movements (Neuper et al. 2005) activate brain regions that are also active during the actual task performance. Based on these findings it is assumed that activation of (motor) representations is responsible for behavioral adaptations after mental training. With respect to postural control, Hamel & Lajoie (2005) and Tia et al. (2010) reported improved performance after motor imagery and movement observation, respectively. Thus, motor imagery and observational training seem to have the potential to improve postural control. However, no previous study has ever tested whether mental non-physical training can improve posture in an unstable, dynamic environment, where sensory feedback is essential in order to counteract external perturbations that cannot precisely be anticipated. Furthermore, it is not known whether these forms of non-physical training can improve sensorimotor function of the cervical spine that is also considered to rely strongly on sensory feedback. The present talk highlights the potential of motor imagery and observation to improve performance in tasks that strongly rely on afferent feedback and displays brain activity (assessed by fMRI and TMS) associated with mental training of different postural tasks. Furthermore, comparisons between young and elderly subjects are made. It will be demonstrated that elderly subjects demonstrate greater cortical activity when mentally simulating postural tasks than young adults. Furthermore, they seem to rely more strongly on visual input in order to activate subcortical brain areas associated with postural control. This might be an important aspect when applying mental simulation techniques in order to maintain or restore sensorimotor function during periods of immobilization. Hallett et al. 1994. *Behav Brain Sci* 17:210 Hamel, Lajoie. 2005. *Aging Clin Exp Res* 17:223-228 Neuper et al. 2005. *Brain Res Cogn Brain Res* 25:668-677 Tia et al. 2010. *Neurosci Lett* 480:138-142

### **MINOR EFFECTS OF A FATIGUING RECUMBENT CYCLING TASK ON FATIGABILITY OF A HAND MUSCLE**

Zijdwind, I.1, Gringhuis, R.1, Hettinga, F.2, Bakels, R.1

*\*UMC Groningen, \*\*University of Essex*

Introduction Muscle fatigue is defined as an exercise-induced reduction in the force generating capacity. Fatigue can be due to changes in the central nervous system (central fatigue) and the peripheral nervous system or muscle (peripheral fatigue; Gandevia, 2001). There is some debate whether muscle fatigue is confined to active muscle groups or that quiescent muscles also show fatigue-related changes in force (Elmer et al., 2013; Rattey et al., 2006). We hypothesized that if fatigue-related changes would manifest themselves in quiescent muscles, that these muscles would show greater fatigability during a sustained contraction following (fatiguing) exercise. Methods Twenty young participants (10 females, 21-26 years) performed a maximal (Bike\_Max, until exhaustion) and a submaximal (Bike\_submax, minor or no fatigue) recumbent cycling exercise test, on two separate occasions separated by 1 week. Before (MVC\_1) and after (MVC\_2) this exercise test, brief maximal voluntary contractions (MVC) of the left index finger abductor (FDI) were assessed. These were immediately followed by a 2-minute sustained index finger abduction and another final brief FDI contraction (MVC\_3). Results The MVC\_1 of the FDI did not differ between the two occasions (56.9N, SD 9.4). MVC\_2 directly following the exercise test was significantly smaller after Bike\_max (86% initial MVC) than after Bike\_submax (94% MVC,  $P=0.04$ ). However, no significant difference was observed after the 2-minute sustained contraction (MVC\_3, Bike\_max: 55% initial MVC; Bike\_submax, MVC\_3, 57% initial MVC,  $P=0.41$ ). During the sustained contraction the force declined significantly ( $P<0.001$ ). No main or interaction effect, however, was found between the two occasions ( $P>0.1$ ). Conclusion Our data only show a small effect of a fatiguing recumbent cycling task on hand muscle force. However, the lack of an effect on the fatigability of this hand muscle suggests that this effect is only short-lasting and of minor importance. References Elmer SJ, Amann M, McDaniels J, Martin DT, Martin JC (2013), Fatigue is specific to working muscles: no cross-over with single-leg cycling in trained cyclists. *Eur J Appl Physiol* 113: 479. Gandevia SC (2001), Spinal and supraspinal factors in human muscle fatigue. *Physiol Rev* 81:1725-1789. Rattey J, Martin PG, Kay D, Cannon J, Marino FE (2006). Contralateral muscle fatigue in human quadriceps muscle: evidence for a centrally mediated fatigue response and cross-over effect. *Pflugers Arch* 452: 199-207.

## **Invited symposia**

### **IS-BN01 DIGITAL SUPPORT SYSTEMS IN RECREATIONAL AND ELITE SPORTS**

#### **TECHNICAL SUPPORT SYSTEMS IN SPORTS: ADAPATED TO INDIVIDUAL NEEDS**

Wolf, P., Rauter, G., Gerig, G., Sigrist, R., Riener, R.

*ETH Zurich*

Introduction A human trainer adapts training to the athlete's individual learning stage, skills, and personality. However, a human cannot observe all physiological and biomechanical variables characterizing the motor task, neither at the same time nor at a high precision. In addition, complex motor tasks may benefit from concurrent multisensory feedback, a type of feedback a human trainer can hardly provide. To overcome these limitations of a human trainer, we developed a technical system that supports a comprehensive assessment of the current performance in rowing, namely the M3-Rowing Simulator (Rauter et al., 2013), and that features concurrent uni- and multi-

modal feedback strategies (Sigrist et al., 2013 & 2014). Besides exemplifying challenges and solutions on how feedback strategies can automatically be selected, we will present results on motor learning experiments where subjects trained either with or without individualized feedback. Methods Sixteen non-rowers were randomly assigned either to an experimental or to a control group. Subjects were requested to learn a typical oar movement in upper body-arm rowing. After a baseline test, subjects trained on two days including five 180s lasting trials with feedback each followed by a 60s lasting non-feedback trial. On a third day, another non-feedback trial (retention test day 3) was measured (protocol similar to Sigrist et al., 2013 & 2014). The experimental group received automatically selected feedback. Therefore, in the non-feedback trials, the most dominant error out of five errors (four spatial and one velocity error) was determined. In the subsequent training a feedback was provided which has been demonstrated to reduce this error. The resulting individual feedback protocol was also presented to one subject of the control group, i.e., the control group was provided with the same feedback, however, the currently most dominant error was not necessarily addressed. Results In contrast to the control group, the experimental group significantly reduced the normalized overall error from baseline to retention tests on day 2 and day 3. The velocity error was significantly reduced by both groups. The experimental group reduced the velocity error significantly more than the control group from baseline to retention on day 2. Discussion One of the largest potentials of technical support systems in sports was explored: Continuously monitored data was used to switch online between feedback strategies. The technical system developed was able to accelerate motor learning when compared to unsupervised provision of concurrent feedback (We also tested a group receiving no feedback – the group did not learn at all). Therewith, a basis is given to explore further features of technical support systems in sports. References Rauter G, Sigrist R, Koch C, Crivelli F, van Raaij M, Riener R, Wolf P (2013). PLOS ONE, DOI: 10.1371/journal.pone.0082145. Sigrist R, Rauter G, Riener R, Wolf P (2013). J Motor Behav, 45, 455-472. Sigrist R, Rauter G, Marchal-Crespo L, Riener R, Wolf P (2014). Exp Brain Res, 1-17.

### WEARABLE COMPUTING SYSTEMS FOR RECREATIONAL AND ELITE SPORTS

Eskofier, B.

*Friedrich-Alexander-Universität Erlangen-Nürnberg*

Wearable computing systems play an increasingly important role in recreational and elite sports. They comprise of two important parts. The first are sensors embedded into clothes and equipment that are used for physiological (ECG, EMG, ...) and biomechanical (accelerometer, gyroscope, ...) data recording. The second are signal processing and data mining algorithms implemented on wearable computers (smartphones, watches, ...) that are used for analysis of the recorded data. Wearable computing systems can provide support, real-time feedback and coaching advice to sportsmen of all performance levels. In order to implement these systems, several challenges have to be addressed. Our group works on four of the most prevalent of these: - Integration: sensors and microprocessors have to be embedded unobtrusively and have to record a variety of signals. - Communication: sensors and microprocessors have to communicate in body-area-networks in a secure, safe and energy-saving manner. - Interpretation: physiological and biomechanical data have to be interpreted using signal processing and machine learning methods. - Usability: interaction with the systems is provided by human-computer-interfaces (HCIs) that have to be intuitive and adapted to several use cases. The talk presents the named challenges and technological solutions to overcome them. The talk is relevant and targeted to researchers aiming to: - include embedded physiological and biomechanical sensors in their studies, - obtain information about secure and energy-efficient communication strategies, - get examples of fundamental concepts of signal analysis and machine learning, - interact with and present information to sportsmen using intuitive HCIs.

### TOWARDS INTELLIGENT FEEDBACK SYSTEMS

Baca, A.

*ISW at the University of Vienna*

Introduction: Technological systems are getting increasingly important for physical activity monitoring and assessment in general and for supervising load and performance in particular. Miniature sensors and computing devices are attached to the athletes or integrated into the sports equipment in order to acquire and process performance or load related data. Ubiquitous computing technologies are thus applied to implement systems, which provide athletes with feedback information on the quality of the motion just performed. The current challenge lies in the development of intelligent systems that cannot only analyse the data but suggest strategies and interventions. One specific concept shall illustrate the potential of such systems. The idea is to provide interactive communication technology in order to assist athletes (recreational and elite sports) in adapting certain performance parameters with respect to the individual performance level. Based on the collected data, which are wirelessly transferred to a server, feedback instructions from (remote) experts having internet access may be given during exercising. Moreover, intelligent algorithms may be integrated into the server application in order to generate feedback instructions automatically. Practical implementations of this concept will be illustrated on the example of long distance running and exercising on weight training machines.

## Invited symposia

### IS-SH07 Lars Magnus Engström Memorial Session

#### A PHILOSOPHICAL PERSPECTIVE ON THE RELATIONSHIP BETWEEN THE LOGIC OF SPORT AND THE ETHICS OF SPORT.

Schneider, A.

*Western University*

What does sport mean? A philosophical perspective on the relationship between the logic of sport and the ethics of sport. A philosophical account will be given about of the meaning and logic of sport in contemporary society, in particular put in relation to ethical issues. More specifically, the question of whether the ethics of sport is tied to the logic of the practice of sports will be addressed. Philosophical analysis of the key concepts of sports, games and play has been declining in more recent years, while much more momentum has developed in the area of ethics in sport. The progress of important ethical positions and concepts has proceeded somewhat independently from careful explanation of exactly what those concepts logically entail. This presentation will be about an examination of whether or not there is a relationship between the two areas of study and if so, what kind of relationship that may be and to what degree. A clearer under-

standing of the potentially diverse logic in various conceptualizations of sport may help to clear the perspectives on some seemingly intractable ethical issues.

### THE LOGICS OF PRACTICE IN SPORTS – OUTLINE OF A THEORY

Larsson, H.

*The Swedish School of Sport and Health Sciences*

Invited symposium. The logics of practice in sports – outline of a theory In 1968, Lars-Magnus Engström started to follow the physical activity patterns of over 2000 Swedes who were born in 1953. This study is still ongoing. In his analyses, Engström found it difficult to analyze his material according to sport concepts or rational motives for doing sports (e.g. health). However, he found useful tools in the work of French cultural sociologist Pierre Bourdieu. Over the years, Engström devoted much attention towards chiseling out a framework for understanding the logics of sport practice, and how these logics can be used to analyse participation patterns and the social stratification of sport. What does sport mean? A philosophical perspective on the relationship between the logic of sport and the ethics of sport The first paper will give a philosophical account of the meaning of sport in contemporary society, in particular put in relation to ethical issues. More specifically, the question of whether the ethics of sport is tied to the logic of the practice of sports will be addressed. The progress of important ethical positions and concepts has proceeded somewhat independently from careful explanation of exactly what those concepts logically entail. This presentation will be about an examination of whether or not there is a relationship between the two areas of study and if so, what kind of relationship that may be and to what degree. A clearer understanding of the potentially diverse logic in various conceptualizations of sport may help to clear the perspectives on some seemingly intractable ethical issues. What does sport mean? Outline of a theory of a logic of sports practices When sports practices and patterns of participation are analysed in research, a common approach by researchers is to understand what people do from the point of view either of what motives that individuals ascribe what they do, or what function the activity might have in relation to, in the case of sport and physical activity for instance, educational or health benefits, or sport performance. This seems, however, to be a way of subjecting practice to a rational logic. Instead, this presentation takes the logic of practice of sport, as it is theorized by Bourdieu, as its starting point. The presentation will outline a number of logics of sports practices that Lars-Magnus Engström has explored, using data from his longitudinal study. The Logic of Sport and the Practice of Sport The third paper will examine the logic of (competitive) sport, in order to illustrate the contribution to this foundational issue that can be made by analytical philosophy. The paper will employ the techniques of conceptual analysis, in suggesting logically necessary conditions for the use of the word 'sport'; and will try to show how the resulting criteria can act both as a demarcation device (between sport and non-sporting activities), and as a source of value prescriptions for sporting practice.

### THE LOGIC OF SPORT AND THE PRACTICE OF SPORT

Parry, J.

*Charles University in Prague*

I will examine the logic of (competitive) sport, in order to illustrate the contribution to this foundational issue that can be made by analytical philosophy. The paper will employ the techniques of conceptual analysis, in suggesting logically necessary conditions for the use of the word 'sport', and will try to show how the resulting criteria can act both as a demarcation device (between sport and non-sporting activities), and as a source of value prescriptions for sporting practice.

## Oral presentations

### OP-SH10 Psychology (Training and Exercise)

#### PERSPECTIVES ON TRAINING APPLIED SPORT PSYCHOLOGISTS IN AUSTRALIA

Marchant, D.

*Victoria University*

In this presentation, I reflect on critical perspectives in developing competence with early career applied sport psychologists from a trainers' perspective. The underlying theme will be looking in and looking out to denote the significance of reflective practice, personal insight and the capacity to adapt. In relation to working with neophyte ASPs the broad objective is developing service-delivery competence (SDC) defined by Tod, Andersen and Marchant (2009) "as the application of suitable psychological theory through the use of appropriate skills and interventions, in a therapeutic relationship to meet a client's needs and expectations, with routine reflection by the practitioner on how they have influenced the process of service provision." For this presentation white water kayaking terminology (e.g., Eddy, Eskimo roll, Feather, Keeper hole, Rapids) will be used as a metaphor for the challenges of assisting neophyte ASPs in 'staying afloat' while they move toward functional competence. In terms of the necessary skills to work successfully over a sustained period in applied sport psychology we focus heavily on eight development themes with neophyte sport psychologists; 1) Intake and counselling skills 2) assessment skills; 3) rapport building; 4) relational skills; 5) domain specific knowledge; 6) knowledge transfer and exchange 7) listening and attending and 8) business skills. Finally, I will draw heavily from the work of Michael Franz Basch (1980, 1988) in describing methods used over a 20 year period to assist young ASPs bridge the gap between theory and practice. Basch, M. F. (1980) *Doing psychotherapy*. New York: Basic books. Basch, M. F. (1988). *Understanding psychotherapy: The science behind the art*. New York: Basic Books. Tod, D., Andersen, M. B., & Marchant, D. B. (2009). A longitudinal examination of neophyte applied sports psychologists' development. *Journal of Applied Sport Psychology*, 21(Suppl. 1), S1-S16. doi:10.1080/10413200802593604



### 10-YEAR CUMULATIVE AND BIDIRECTIONAL ASSOCIATIONS OF PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR DOMAINS WITH HEALTH-RELATED QUALITY OF LIFE IN FRENCH ADULTS

Omorou, A., Menai, M., Lata arche, C., Kesse-guyot, E., Oppert, J.M., Hercberg, C., Briançon, S., Vuillemin, A.

*University of Lorraine*

Background: The causality and directionality of the associations of domains of physical activity (PA) and sedentary behavior (SB) with health-related quality of life (HRQoL) in adults remain to be defined. This study investigated the longitudinal association of 10-year cumulative levels of PA and SB with HRQoL and the reverse association. Methods: A sample of 2,093 individuals from a 10-year cohort of French adults (SU.VI.MAX trial) was included. Data were collected at three time points (1998, 2001 and 2008) using the Modifiable Activity Questionnaire (MAQ) for PA and SB and the DUKE Health Profile for HRQoL (physical, mental, social and general health dimensions). PA domains corresponded to occupational and leisure-time while SB domains corresponded to leisure time spent screen-viewing, reading or sitting. The cumulative level (from 0 to 3) referred to the number of time points where a high PA level (> 2h30min/week for leisure-time PA and > 7h/week for occupational PA), high SB (> 2h/day for screen-time, > 1/day for reading and > 4h/day for total sitting time) or good HRQoL (greater or equal to French adults normal values) was reported. Regression analyses first examined the cumulative level of high PA, high SB as predictors of HRQoL at 10-year follow-up and reverse associations. Results: The 10-year cumulative level of high leisure-time PA predicted a high HRQoL score in the four dimensions while occupational PA predicted a high score in only physical and general health. Cumulative level of high screen-viewing time and high total sitting time was associated with lower HRQoL score respectively for physical health dimension and physical and general health dimensions. The cumulative level of high reading-time was associated with high mental and social health scores. In the reverse association, cumulative level of good HRQoL predicted more leisure-time PA, less screen-viewing time and less total sitting time but was not related to occupational PA. Only good social health predicted more reading-time. Conclusion: Cumulative and bidirectional PA-HRQoL associations were observed for leisure-time PA and time spent screen-viewing with most HRQoL dimensions. Other associations were less consistent. Relationships between PA, SB and HRQoL are complex and should not be oversimplified in one or the other direction. Taking into account the specific domains of PA and SB in health promotion programs appears of importance to design interventions aiming at improving HRQoL in adults.

### INVESTIGATING THE INTERACTION BETWEEN THE BIG-FIVE AND DISPOSITIONAL COPING IN SPORT

Kaiseler, M., Levy, A.

*Leeds Beckett University; Edge Hill University*

Introduction It has been recommended (Allen, Greenlees, & Jones, 2011) that future research should consider how personality traits interact in determining specific types of sport related coping. Accordingly, this study aimed to explore what combinations of the Big-Five personality taxonomy are associated with sport-related coping. Methods Data was collected among four hundred UK athletes (male n = 237, female n = 163), aged between 18-48 years (Mage = 22.97 SD =7.0). Participants completed the Big-Five Inventory (BFI; John, Donahue, & Kentle, 1991) and the 37-item Dispositional Coping Inventory for Competitive Sport (DCICS; Hurst, Thompson, Visek, & Gaudreau, 2011). Results Hierarchical multiple regressions were conducted for each coping subscale. At step one demographic variables were entered, at step two the Big-Five personality traits were added, and at step 3 two-way interaction effects were included. For task-oriented coping, the inclusion of a two-way interaction effect (R<sup>2</sup>adj = .255) showed a significant effect for the interaction between extraversion and neuroticism ( $\beta = -.19, P < .001$ ), alongside neuroticism and openness ( $\beta = .15, P < .01$ ). For distraction coping, the inclusion of a two-way interaction showed a significant interaction (R<sup>2</sup>adj = .380) for agreeableness and conscientiousness ( $\beta = .20, P < .001$ ). Finally, for disengagement coping a significant two-way interaction effect (R<sup>2</sup>adj = .403) was found for extraversion and neuroticism ( $\beta = -.10, P < .05$ ). Discussion Findings revealed that athletes who were low neurotic in conjunction with high extraversion and openness were more likely to report task-oriented coping. Distraction-oriented coping was preferred by athletes low in both conscientiousness and agreeableness traits. Finally, low extraversion and high neuroticism was associated with greater use of disengagement-oriented coping. The current findings reinforce the need to investigate the interactive effects of personality dimensions upon sport-related coping. Doing so would assist applied practitioners to maximise the potential of coping-related interventions by targeting particular personality profiles. References Allen, M.S., Greenlees, I., & Jones, M. (2011). An investigation of the five-factor model of personality and coping behaviour in sport, *Journal of Sports Sciences*, 29, 841-850. Hurst, J.F., Thompson, A., Visek, A.J., Fisher, B. & Gaudreau, P. (2011). Towards a dispositional version of the coping inventory for competitive sport. *International Journal of Sport Psychology*, 42, 167-185. John, O.P., Donahue, E.M., & Kentle, R.L. (1991). *The Big Five Inventory – Versions 4a and 54*. Berkeley: University of California, Berkeley, Institute of Personality and Social Research.

### COMPETENCES REQUIRED BY ELITE ATHLETES IN TERTIARY EDUCATION

De Brandt, K., Wylleman, P., Van Rossem, N.

*Vrije Universiteit Brussel*

Introduction. Student-athletes perceive challenges in different domains when they make their transition into higher education. To cope with these transitional challenges, student-athletes require specific competences to optimize their preparation for and their development throughout their dual career 'elite sport and higher education' pathway. While past research has focused on structural and organizational initiatives in the topic of dual careers, there is a lack of knowledge with regard to the competences athletes require to successfully combine elite sport and higher education. Theoretical framework. This study used the Holistic Athletic Career model from Wylleman, Reints, & De Knop (2013) to explore the competences needed by student-athletes to successfully initiate their combination of elite sport and higher education. Methodology. Using a retrospective design, semi-structured interviews were conducted with nine elite student-athletes who 'successfully' initiated their elite sport and higher education pathway. 'Successfully' means that all participants had academic success rates above university average and competed at international level. Results. Elite student-athletes require skills, attitudes, knowledge and experiences at the athletic, psychological, psychosocial, academic and financial level in order to successfully initiate a dual career in higher education. These include, amongst others, coping with athletic and academic related pressure, goal setting, effective use of time, prioritizing tasks, being able to live alone in a student house, and self-discipline. Further detailed results will be presented. Practical implications. In order to optimize the transition and integration of athletes into higher education, structural and organizational initiatives together with dual career support services need to be complemented with athletes having sufficient, effective and transferable competences in order to be able to take full responsibility for developing their own dual career pathway. Support services should be aware of the competences that student-athletes require so they can provide their athletes with tailor-made support (e.g. teaching them

time management and self-regulatory skills) prior to and during the transition into higher education. References. Wylleman, P., Reints, A., & De Knop, P. (2013). A developmental and holistic perspective on the athletic career. Abstracts of the ISSP 13th World Congress of Sport Psychology. (p. 2). Beijing.

## Oral presentations

### OP-PM47 Training & Testing: Fatigue II

#### THE IMPACT OF A 3 WEEKS DETRAINING PERIOD ON FOREARM MUSCLE PERFUSION AND OXYGENATION IN MALE AND FEMALE ROWERS DURING INCREMENTAL HANDGRIP EXERCISE

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**Introduction** The purpose was to study the effect of a 3 weeks detraining period on forearm blood flow (FBF) and muscle oxygenation (deoxy[Hb+Mb]) during an incremental cyclic contraction protocol (ICCP) in oarsmen. **Methods** A population of 11 rowers (8 ♂, 3 ♀) from the Belgian national team were selected to perform ICCP after a 10 weeks training period (pre-test) and after 3 weeks of detraining (post-test). Before ICCP, maximal voluntary contraction (MVC) was determined for each individual, whereas FBF (ml/min) and deoxy[Hb+Mb] (expressed in % towards the arterial occlusion maximum value) were measured during ICCP using Doppler US and NIRS respectively. Peak force during ICCP was determined and ICCP peak FBF and peak deoxy[Hb+Mb] were divided by this peak force. **Results** The results showed a higher MVC during post-test ( $605,5 \pm 88,0$  N) compared to the pre-test ( $556,6 \pm 110,8$  N) ( $p=0,009$ ). However, absolute peak FBF was decreased during the post-test ( $664,9 \pm 303,6$  ml/min) compared to the pre-test ( $803,8 \pm 370,8$  ml/min) ( $p=0,030$ ). Furthermore, the ratio peak FBF on peak force showed lower values during the post-test ( $1,7 \pm 0,83$  ml/min/N) in comparison with the pre-test ( $2,1 \pm 0,82$  ml/min/N) ( $p=0,043$ ). No significant differences were found in relative peak values of deoxy[Hb+Mb] during the post-test ( $55,8 \pm 23,0$  %) compared to the pre-test ( $51,9 \pm 23,8$  %) ( $p=0,725$ ). The ratio peak deoxy[Hb+Mb] on peak force showed no significant differences ( $p=0,377$ ) between both test moments. **Discussion** To conclude, firstly, we observed an increased MVC after 3 weeks of detraining. The higher MVC could be an effect of a decreased fatigue (due to an intensive training schedule) relative to the fitness of the athletes. Secondly, a decreased peak FBF and a decreased peak FBF on peak force ratio were observed after a 3 weeks detraining period. This can be partly explained by the loss of training induced physiological adaptations during short term detraining [2].

#### MUSCLE TISSUE DESATURATION IN TRAINED MALE AND FEMALE CYCLISTS

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**Background:** At high exercise intensities, physical performance may be limited by insufficient oxygen supply to the muscle fibers. Whether there is a (mismatch between oxygen demand and supply may be assessed measuring the muscle tissue oxygen saturation (TSI), which reflects the dynamic balance between oxygen supply and utilization. Oxygen saturation is generally measured by near infrared spectroscopy (NIRS). However, these measurements are likely affected by adipose tissue thickness (ATT) and therefore do not fully resemble physiological saturation values. Therefore, untrained or female subjects are usually excluded from analyses and rather slim males have been studied. **Purpose:** Determine whether there is a difference in measured oxygen desaturation throughout maximal incremental exercise between trained female and male cyclists. **Methods:** Twenty trained cyclists (10 male, 10 female) completed a maximal incremental cycling test 30-45W:3min<sup>-1</sup> at 90 rpm. TSI was obtained from mm. vastus lateralis (VL) and medialis (VM) by continuous-wave NIRS. Adipose tissue thickness (ATT) was determined by skinfold measurements. Ventilatory threshold (VT) was assessed by V-slope and respiratory compensation point (RCP) by ventilatory equivalents. Differences in ATT and maximal desaturation were analyzed by independent t-tests and TSI desaturation by mixed design ANOVAs (gender x threshold (VT-RCP-MAX)). **Results:** Both sexes showed significant desaturation throughout incremental exercise (Rest/M,  $p<0,001$ ). Women showed lower desaturations during incremental exercise compared to men (VL: 10.5 vs. 30.2%,  $p<0,001$ ; VM: 8.6 vs. 20.7%,  $p<0,01$ ) and higher ATT levels (VL: 8.4 vs. 3.3mm,  $p<0,001$ ; VM: 8.6 vs. 4.4mm,  $p<0,01$ ). The desaturation during incremental exercise was negatively related to ATT ( $n=20$ ;  $r_{VL}=-0,81$  and  $r_{VM}=-0,76$ ,  $p<0,001$ ). **Conclusion:** ATT confounds NIRS measurements of physiological oxygen desaturation throughout incremental exercise, resulting in higher measured saturation levels and smaller desaturations as well as smaller signal-to-noise ratios in trained female compared to male cyclists. Therefore, comparison of (de)saturation profiles in athletes needs to take into account differences in ATT. Even though the trained female cyclists present higher ATT levels, they still show significant measured oxygen desaturations during incremental exercise as well. **Funding:** Technologiestichting STW

#### MAXIMAL AEROBIC POWER ASSESSMENT FOR PERFORMANCE: SHOULD WE CONSIDER SKELETAL MUSCLE OXYGENATION AND MINUTE VENTILATION?

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Time and again, exercise specialists are faced with test results and try to contrive a better physiological rationale for determining maximal aerobic power (MAP). This is especially true when a subject, at the end of a graded exercise testing (GXT) cannot complete a full step or consumes less oxygen than that required by the imposed workload. The purpose of this study was to arrive at a more accurate MAP test, by looking deeper into the data, exploring the concomitant behaviour of  $\dot{V}O_2$  against pulmonary minute ventilation ( $\dot{V}_E$ ), skeletal muscle oxygenation and  $O_2$  pulse. Twenty nine active to world class male cyclists (age =  $28,8 \pm 9,2$  years, height =  $177,1 \pm 6,0$  cm, weight =  $70,8 \pm 7,3$  kg, mean  $\dot{V}O_{2max}$  of  $65,8 \pm 7,9$  ranging from 52.6 to 80.2 ml $O_2$ •min<sup>-1</sup>•kg<sup>-1</sup>) of different training status took part in the study. All participants performed a MAP test starting at 130 W and successively stepped up by 30 W increments. The duration of the step efforts was 5 minutes, cushioned by 3 minutes recovery periods at 1 W per kg of body weight. We compared the gain obtained in  $\dot{V}O_2$ ,  $\dot{V}_E$ , ventilatory equivalent ratio for oxygen ( $\dot{V}_E/\dot{V}O_2$ ), skeletal muscle oxygenation by NIRS (deoxyhemoglobin; HHb), heart rate (HR) and oxygen pulse ( $O_2$  pulse) at the last step of the GXT, versus the average gain registered at the preceding steps. Results show that the gain obtained at the last completed step of the GXT and the average gain in  $\dot{V}O_2$  ( $381,16 \pm 131,2$  vs.  $372,19 \pm 56,5$  ml $O_2$ •kg<sup>-1</sup>•min<sup>-1</sup>) were

similar ( $p = 0.71$ ). However, 14 of the 29 subjects did not show a higher gain in  $\dot{V}O_2$  at the last completed step as compared to the average gain ( $-101.07 \pm 82.9$  ( $n=14$ ) vs.  $+98.38 \pm 79.7$  ( $n=15$ )  $\text{mlO}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ). In particular, the gain in HHb was lower ( $p < 0.001$ ) in 24 of the 29 subjects ( $-1.23 \pm 0.70$ ;  $n=24$  vs.  $1.11 \pm 0.66$ ;  $n=5$  arbitrary units) at the last step of the GXT. The gain in Ve at the last completed step was increased ( $p < 0.001$ ) by 147% ( $32.92 \pm 10.01$  L/min) as compared to the average gain of the preceding steps ( $13.31 \pm 2.9$  L/min). The mean gain in  $\dot{V}E/\dot{V}O_2$  during the GXT ( $1.15 \pm 0.7$  L/ $\dot{V}O_2$ ) was also increased at the last completed step ( $4.81 \pm 2.3$  L/ $\dot{V}O_2$ ,  $p < 0.001$ ). No significant changes were observed between steps for HR and O<sub>2</sub> pulse. Twenty six subjects attempted a final uncompleted step, but only two were able to show a higher gain in  $\dot{V}O_2$  as compared to their preceding average gain. In conclusion, a subject may, partially or successfully, reach a higher power output, but he may not necessarily consume more oxygen in the skeletal muscle. This disproportionate increase in ventilation and the corresponding decrease in HHb suggest that aerobic power assessment needs to be adjusted for estimating a 'true aerobic power' for exercise prescription. Claude.lajoie@uqtr.ca

### USING DIFFERENTIAL RATINGS OF PERCEIVED EXERTION TO MEASURE INTERNAL LOAD

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**Introduction** Differential ratings of perceived exertion (dRPE) enhance the precision of internal load measurement by discriminating between central (e.g. breathlessness, RPE-B) and peripheral (e.g. leg, RPE-L) perceived exertion (Weston et al., 2014). A more detailed analysis of dRPE with physiological measures collected during contrasting exercise modes is required, however. Further, the influence of post-session timing when collecting dRPE is as yet unexplored. Our aim was to investigate the sensitivity of dRPE as measures of internal load and to explore the effect of timing on dRPE. **Methods** Twelve university male soccer players performed 2 maximal incremental exercise protocols (Treadmill, Cycle) in a counterbalanced manner, separated by 3-7 days. Maximal heart rate (HRmax), maximal oxygen uptake ( $\dot{V}O_{2\max}$ ), peak blood lactate (BLa) and pre-post protocol change in countermovement jump height (CMJ) were measured for each protocol. Players provided dRPE (CR100) immediately upon exercise termination (RPE-B0, RPE-L0) and 30-minutes post exercise (RPE-B30, RPE-L30). Data were analysed using magnitude-based inferences. **Results** The between protocol differences were most likely large for HRmax (Treadmill  $197 \pm 8$  b.min vs Cycle  $186 \pm 12$  b.min, mean difference 5.9%;  $\pm 90\%$  confidence limits 2.3%) and CMJ ( $1.4 \pm 4.5$  cm vs  $7.4 \pm 4$  cm,  $-24.9\%$ ;  $\pm 7.4\%$ ), likely moderate for  $\dot{V}O_{2\max}$  ( $52.1 \pm 4.8$  ml.kg.min vs  $49.2 \pm 6.9$  ml.kg.min, 6.1%;  $\pm 5.0\%$ ) and likely small for BLa ( $8.5 \pm 2.2$  mmol vs  $9.4 \pm 1.8$  mmol,  $-12.3\%$ ;  $\pm 16.3\%$ ). There was a very likely large difference (17.5%;  $\pm 6.8\%$ ) in RPE-B0 between Treadmill ( $95.4 \pm 7.5$  AU) and Cycle ( $79 \pm 13$  AU) and likely small difference in RPE-L0 ( $-10.1\%$ ;  $\pm 10.5\%$ ) between Treadmill ( $86 \pm 12$  AU) and Cycle ( $94 \pm 11$ ). The difference in RPE-B30 was likely small (11.4%;  $\pm 13.9\%$ ) between Treadmill ( $80 \pm 16$  AU) and Cycle ( $71 \pm 13$  AU) and very likely moderate for RPE-L30 ( $-34.1\%$ ;  $\pm 27.1\%$ ) between Treadmill ( $68 \pm 21$  AU) and Cycle ( $87 \pm 13$  AU). The effect of timing for RPE-B was likely large for Treadmill ( $-17.7\%$ ;  $\pm 9.6\%$ ) and trivial for Cycle ( $-11.6\%$ ;  $\pm 6.1\%$ ). For RPE-L, the timing effect was very likely large for Treadmill ( $-23.9\%$ ;  $\pm 11.1\%$ ) and very likely moderate Cycle ( $-7.3\%$ ;  $\pm 4.6\%$ ). **Discussion** Our small to large differences between RPE-B and RPE-L collected following maximal exercise performed on different modes support that dRPE represent different dimensions of effort, thereby supporting their usefulness as measures of internal load. The intensity of activities completed during the final stages of a maximal exercise protocol does influence dRPE, although this appears to be dependent on exercise mode. We recommend that further investigations concerning dRPE and potential timing effects be undertaken during regular training sessions. **References** Weston et al. *J Sci Med Sport* 2014. In press.

### FASTER HEART RATE RECOVERY WITH INCREASED RPE LEVELS AFTER AN 87 KM ULTRA-MARATHON: PARADOXICAL FINDINGS WITH IMPLICATIONS FOR MONITORING ATHLETES

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**Introduction** Changes in heart rate recovery (HRR) are generally associated with changes in training status and this measurement shows potential as a valuable monitoring tool (Capostagno et al.). Faster HRR has been linked with an improvement in training status whereas slower HRR has been linked with a decrease in training status. However, two recent studies have found faster HRR after a significant increase in training load (Dupuy et al., Lamberts et al.), suggesting that faster HRR may not always reflect an adapted state. In order for day-to-day changes in HRR to be interpreted accurately, further clarity on the relationship between HRR and day-to-day changes in training status is required. With this in mind, the aim of this study was to determine the relationship between HRR and an acute training "overload" by comparing HRR responses before and after an ultra-marathon road race. **Methods** Ten runners completed a standardized laboratory protocol ~7 days before and between 2 and 4 days after participating in the 87 km Comrades Marathon. The protocol included muscle pain ratings, a 5 bound test and 20 min of treadmill exercise at 70% of maximal oxygen uptake followed by 15 min of recovery. Respiratory gases and heart rate measurements were used to calculate steady state exercise responses, HRR and excess post-exercise oxygen consumption and participants also provided a rating of perceived exertion during exercise (RPE). **Results** All participants completed the 87 km race with finishing times of between 8 h 11 min and 11 h 39 min. A strong correlation was found between PTRS and race finishing time ( $r = -0.89$ ,  $p = 0.0005$ ), suggesting that all runners attempted to complete the race in the fastest possible time. During the post-race submaximal exercise test, RPE was significantly higher ( $13 \pm 2$  vs.  $11 \pm 1$ ;  $p < 0.01$ ) while HRR was significantly faster ( $35 \pm 5$  vs.  $29 \pm 4$  beats;  $p < 0.01$ ). No other significant changes in respiratory or heart rate parameters were observed. **Discussion** This study found faster HRR along with increased RPE levels in runners who completed an 87 km ultra-marathon. These findings are paradoxical, as a faster HRR is often associated with positive training adaptation. However, our findings are in line with the work of Dupuy et al. and Lamberts et al. who reported a faster HRR in functionally overreached athletes. The current study emphasises that changes in HRR should always be interpreted in the light of changes other parameters. As submaximal parameters, as HRR and RPE, are able to reflect changes in training status (Daanen et al.) and a state of overreaching, they are promising parameters to monitor and fine tune training prescription in athletes. **References** Capostagno B. et al (2013) *Int. J. Sports. Physiol and Perform.* 9:292-301 Dupuy O et al. (2013). *Appl Physiol Nutr Metab* 38: 200-208 Lamberts RP et al. (2010) *Eur J Appl Physiol* 108: 183-90, 2010. Daanen et al (2012) *Int. J. Sports. Physiol and Perform.* 7:251-260 Contact: theresa.mann@gmail.com or RPLamberts@gmail.com

**MEASURING THE FATIGUE EFFECT ON ICE HOCKEY SKILLS DURING A TESTING PROTOCOL CONDUCTED AMONG ELITE HOCKEY PLAYERS**

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**Introduction** In ice hockey, most testing procedures refer to physiological parameters, without taking consideration of multiple technical skills (Behm et al., 2005; Burr et al., 2008). In this regard, more complete testing protocol seems to be optimal to verify about the impact of fatigue on performance. This study aims to measure the impact of fatigue during a multi-dimensional (i.e. physiological and technical) ice hockey testing protocol among a group of elite hockey players. **Methodology** Six males, university level hockey players ( $21.8 \pm 0.55$  year) accepted to take part to an on-ice testing protocol. The suggested protocol is in its pilot phase for further testing among other sub-populations. Each player had to complete a repetitive testing circuit six times, with a work-rest ratio of 1:2, as it is recommended by Cox et al (1995). Speed, acceleration, decision making, agility, shooting abilities and rated perceived exertion (RPE) were measured at each repetition. Repeated measures ANOVAs were conducted to verify the evolution of each of the protocol's component. Post hoc analyses were conducted to identify specific variations in performance. **Results** Results revealed a significant diminution of performance in shooting abilities ( $F = 4.52$   $p = .005$ ). Speed and acceleration declined, but not significantly ( $p > .10$ ). Agility and decision making were improved during the protocol, but not significantly ( $p > .15$ ). However, RPE increased over the protocol ( $F = 3.52$   $p = .015$ ). In summary, post hoc analyses revealed that most of significant differences appeared at the fifth and sixth repetition. **Discussion** In general, fatigue seems to affect acuity skills such as shooting precision. In general, players adapted well to most tasks especially in agility and decision making. The performance level of players and timing of assessment (i.e. mid season) could explain small effects of fatigue on most hockey skills. Further research should be conducted among players of multiple competition levels. **References** Behm, D. G., Wahl, M. J., Button, D. C., Power, K. E., & Anderson, K. G. (2005). Relationship between hockey skating speed and selected performance measures. *J Strength Cond Res*, 19(2): 326-331. doi: 10.1519/r-14043.1 Burr, J. F., Jamnik, R. K., Baker, J., Macpherson, A., Gledhill, N., & McGuire, E. J. (2008). Relationship of physical fitness test results and hockey playing potential in elite-level ice hockey players. *J Strength Cond Res*, 22(5): 1535-1543. doi: 10.1519/JSC.0b013e318181ac20 Cox MH, Miles DS, Verde TJ, Rhodes EC.(1995) Applied physiology of ice hockey. *Sports Med*. 1995 Mar; 19(3):184-201.

**Oral presentations****OP-PM75 Molecular Biology and Biochemistry****RELIABILITY OF TRUNK MUSCLE ELECTROMYOGRAPHY DURING LOADED BACK SQUAT EXERCISE.**

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**Introduction.** Surface electromyography (sEMG) has recorded trunk muscle activation (TMA), during back squat exercise (Clark et al. 2012). However, the inter day reliability and sensitivity to different loads, of sEMG from such exercise alongside kinematic measures, has not been reported. **Aims:** to determine the inter day reliability and load sensitivity of TMA sEMG and kinematics during back squats **Methods.** Ten males performed 3 test sessions: 1) back squat 1RM was determined; 2) and 3) 3 repetitions at 65, 75, 85 and 95% of system mass max (SMmax) (Brandon et al. 2011). Kinematics were measured from an electrogoniometer and linear transducer and sEMG were recorded from vastus lateralis (VL), rectus abdominus (RA), external oblique (EO), upper lumbar erector spinae (ULES) and lumbar sacral erector spinae (LSES). sEMG amplitude was determined by Root Mean Squared (RMS). Mean RMS for test loads 75, 85 and 95% SMmax was normalized to the mean RMS at 65% SMmax for each phase of the squat respectively. **Results.** No differences ( $p > 0.05$ ) existed between tests for any kinematics and intra subject CV% for all data ranged from  $1.2 \pm 0.7\%$  to  $11.7 \pm 12.6\%$ . Eccentric power increased ( $p < 0.05$ ) with each load increment and concentric power followed established load, power relationship (Cormie et al. 2007). Between test differences in mean RMS for each muscle in each squat phase ranged from  $-26.6 \pm 25\%$  to  $26.1 \pm 26.3\%$  and intra subject CV% for all EMG data ranged from  $29.4 \pm 1.2\%$  to  $12.6 \pm 7.2\%$ . ICC for all loads demonstrated fair relative reliability for just RA (0.60) and EO (0.71) in the eccentric and the LSES (0.60) in the concentric phase. RMS significantly ( $p < 0.05$ ) increased alongside load for all muscle sites in the eccentric phase and in the concentric phase for ULES, LSES and EO only ( $p < 0.05$ ). **Discussion.** TMA increased linearly across load in all muscles in the eccentric phase and the posterior stabilizers in the concentric phase; therefore, the loaded squat is an effective training stimulus for the trunk stabilizers. However, researchers and practitioners should only record sEMG from certain trunk muscles, depending on the contraction phase, for reliable and repeatable measurement. **References** Brandon, R., Howatson, G., & Hunter, A. (2011) *J.Sport Sci.*, 29, 1389-1397. Clark, DR., Lambert, M., & Hunter, AM. (2012) *JSCR*.26(4):1169-78. Cormie, P., McBride, J.M., & McCaulley, G.O. (2007) *J of Applied Biomechanics*, 23(2), 103-118. Contact: dave.clark@irfu.ie

**NEUROMUSCULAR FATIGUE DURING LOW-INTENSITY ISOMETRIC EXERCISE WITH BLOOD FLOW RESTRICTION**

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**Introduction:** Light-load resistance exercise with blood flow restriction (BFR) has been shown to increase muscle strength and mass similarly to heavy-load resistance exercise. Since fatiguing exercise is suggested as a potent stimulator to increase muscle mass, it is important to characterise the rate of fatigue with BFR during resistance exercise. Therefore, the purpose of this study was to determine the effect of BFR on muscle fatigue via the decline in force of maximal voluntary contractions (MVCs) during isometric knee extension exercise. **Methods:** A randomized, counterbalanced, within-subject design was used to investigate the effect of BFR on muscle fatigue during unilateral isometric knee extension exercise (Biodex 4, USA). Untrained male participants ( $n=12$ ;  $24 \pm 1$  yrs) completed four testing sessions separated by one week: four sets (30 repetitions, followed by 3 sets of 15) at 20% MVC with BFR (BFR20) or without (CON20), and two conditions that excluded the 20% MVCs (BFRX and CONX). To evaluate fatigue each trial, a baseline MVC prior to beginning each trial (MVC1) was compared with an MVC completed for every 7th repetition (4 during the first set, followed by 3 in sets 2-4). MVC force, surface electromyography (EMG) and peripheral nerve stimulation (M-Wave) were recorded during each MVC. **Results:** MVC1 (baseline) was not different between trials ( $284 \pm 30$  N). There was a trial x time interaction for MVC force ( $P \leq 0.05$ ). MVC force decreased significantly from

MVC1 to end of set 1 (MVC5) for all trials (~235 N; 11%;  $P \leq 0.01$ ), however there were no differences between trials. Following this, MVC force returned to baseline level for both CON20 and CONX during all subsequent MVCs (6-14). However, in comparison with MVC1, force continued to decrease throughout all subsequent sets for both BFR20 (MVC14; 199 N; 25.0%;  $P \leq 0.01$ ) and CONX (214 N; 22.8%;  $P \leq 0.01$ ). In addition, MVC force was significantly lower for both BFR trials compared with both CON trials ( $P \leq 0.05$ ). There were no trial x time interactions, or main effects for trial or time for EMG activity during MVCs and 20% contractions. Discussion: Previous investigations have shown a decrease in force immediately post-exercise, and at 24- and 48-hours post-exercise. This was the first study to demonstrate a decline in MVC force throughout a standard BFR resistance exercise protocol (i.e. 30/15/15/15 repetitions). Of note, BFR was shown to be more fatiguing than LLRE regardless of an exercise intervention being performed. It is possible that different mechanisms are responsible for the decline in MVC force for both BFR trials, but might be due to an increase in metabolic by-products, hypoxia, and overall a decrease in central drive from higher brain centres. Contact Christopher Brandner, B.ExSS (Hons) PhD Candidate [chris.brandner@aspire.qa](mailto:chris.brandner@aspire.qa)

## LONG-RANGE CORRELATIONS IN THE FLUCTUATIONS OF STANCE, SWING AND DOUBLE-SUPPORT TIMES IN NORMAL WALKING

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Introduction: Plenty of research documents long-range correlations in stride interval fluctuations under different conditions for healthy subjects, while it has been shown that this structure breaks down with aging and several pathologies [1-8]. But are there also long-range correlations in the fluctuations of stance, swing and double-support-times? Methods: 48 students of the Institute for Sports Sciences (height 178cm  $\pm$  11.3, weight 72,1kg  $\pm$  12, age 23,5 years  $\pm$  3,92) that had no acute or chronic lesions or diseases of the lower extremities carried four 3D accelerometers (Analog Devices ADXL 326), which were mounted to the distal end of Os metatarsale III and below the Malleolus lateralis of each foot. Sampling frequency was set to 2000 Hz. Subjects were instructed to walk at PWS for consecutive 20 to 25 minutes. Two double-photoelectric barriers measured locomotion velocity several times during the trial. Average locomotion velocity for the group was 1,57 m/s  $\pm$  0,16 with an average SD for the single subject of 0,02 m/s. Results: After separating the accelerometer time-series into stride intervals, stance, swing and double-support time (=DST) their duration was selected resulting in a total of 13.552 step cycles that could be included in the analysis. Detrended fluctuation analysis (=DFA) was performed and compared to a surrogate-data test (thousandfold randomization). DFA resulted in  $\alpha = 0,86$  for stride interval,  $\alpha = 0,78$  for stance,  $\alpha = 0,66$  for swing and  $\alpha = 0,62$  for DST. All of them showed significant differences to the surrogates we can, therefore, deduce that those are long-range correlations. Discussion: The  $\alpha$  of the single phases show long-range correlations that are below the ones for stride interval. One suspects to find a synergy between stance and swing that sum up to stronger long-range correlations for stride interval. Testing this with a technique similar to the uncontrolled manifold hypotheses did not provide clear results. It is further still unknown, what the physiological mechanisms are that underlie the production of long-range correlations. References [1]. Ashkenazy Y, Hausdorff JM, Ivanov, PC, Stanley HE (2002). *Physica A*, 316:662-670 [2]. Bollens B, Crevecoeur F, Nguyen V, Detrembleur C, Lejeune T (2010), *Gait & Posture* 32(3):369-373 [3]. Goldberger AL, Peng C-K, Lipsitz LA (2002), *Neurobiol Aging* 23(1):23-26 [4]. Hausdorff JM, Peng C-K, Ladin CK, Wei JY, Goldberger AL (1995), *J Appl Physiol* 78:349-358 [5]. Jordan K, Newell, KM (2008), *Exerc Spo Sci Rev* 36(4):200-204 [6]. Kang HG, Dingwell JB (2008), *Gait & Posture* 27(4):572-577 [8]. Terrier P, Dériaz O (2012), *Hum Mov Sci* 31(6):1585-1597

## CORTICAL CONTROL OF GAIT FUNCTION IN PEOPLE WITH PARKINSON'S DISEASE: A PILOT STUDY

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INTRODUCTION Gait difficulties (e.g. small steps, freezing) are common symptoms of Parkinson's disease (PD) [1]. Neuroimaging studies suggest that alterations in the structure and function of basal ganglia and cortico-frontal networks contribute to gait disorders in PD [1,2]. However, the exact neural mechanisms are not well understood [1]. In this study we compare corticomuscular coherence (CMC) during treadmill and natural overground walking to investigate the contribution of motor cortical activity to gait control in people with PD. METHODS Four PD individuals (61.1 $\pm$ 9.3 years; H&Y 1.2 $\pm$ 0.45) performed overground and treadmill walking at a comfortable, self-selected pace (3.4 $\pm$ 0.6 km/h). EEG was recorded from 12 sites; bipolar EMG was recorded bilaterally from 4 leg muscles (Tib. Ant. (TA), Sol., lateral & medial Gastroc.). Pooled coherence was computed between the Cz EEG electrode and the TA muscle of the right leg using the MATLAB toolbox NeuroSpec 2.0. Time-dependent coherence was calculated relative to the heel strike of the right foot. RESULTS During overground walking, CMC was significant at 1-5Hz from -800 to -350 ms prior to heel strike and at 3-11Hz from -350 to 0 ms prior to heel strike. During treadmill walking, CMC was significant at 1-9Hz from -800 to -350 ms prior to heel strike. When comparing both gait modalities, CMC in the 5-9 Hz range was significantly higher during treadmill walking from -750 to -350 ms prior heel strike and during overground walking from -350 to 0 ms prior to heel strike ( $p < 0.01$ ). In the 1-4Hz range, CMC was significantly higher during overground walking at most times of the gait cycle ( $p < 0.01$ ). DISCUSSION For people with PD overground walking may utilize different neural circuits than treadmill walking. The significant CMC under 11 Hz prior to heel strike during overground and treadmill walking is lower than reported for healthy people who exhibit significant beta-band coherence (24-40 Hz) [3]. This suggests deficient cortical drive to the muscle in the beta-band in people with PD. However, our findings should be interpreted with caution due to the small sample size and the lack of a control group. Further research is warranted to confirm these deficiencies in cortical control of gait function in people with PD. REFERENCES [1] Maillet A, et al. (2012) Imaging gait disorders in parkinsonism: a review. *J Neurol Neurosurg Psych* 83: 986-993. [2] Herman T, et al. (2013) Neuroimaging as a window into gait disturbances and freezing of gait in patients with Parkinson's disease. *Curr Neurol Neurosci Rep* 13: 411. [3] Petersen TH, et al. (2012) The motor cortex drives the muscles during walking in human subjects. *J Physiol* 590: 2443-2452. CONTACT [l.roeder@qut.edu.au](mailto:l.roeder@qut.edu.au)

## EFFECTS OF ECCENTRIC WORKLOADS ON MUSCLE MICROCIRCULATION AND NEUROMECHANICAL CHARACTERISTICS OF THE KNEE EXTENSOR MUSCLES

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The aim of this study was to evaluate and compare the effects of two eccentric workloads on muscle activation and fast force capacity in quadriceps muscles in asymptomatic players by measuring the muscle activation and fast force capacity both before and after 4 sets of a knee extension exercise. Muscle microcirculation values during the exercise were also compared. Seventeen college tennis players were

randomly assigned to perform 4 sets of either 40 repetitions (n=9, age: 20.0 ± 1.5 y) or 80 repetitions (n=8, age: 21.5 ± 1.0 y) of the eccentric exercises. The muscle activation, measured by rate of EMG rise (RER), and the rate of force development (RFD) in the quadriceps muscles during the isometric knee extensions were measured pre- and post-exercise in all subjects. Muscle microcirculation in the vastus lateralis muscle during the fourth set was also measured. The results revealed that reductions of rectus femoris muscle activation occurred only after eccentric exercises with sets of 80 repetitions; however, reductions in the vastus muscles were observed in both exercise groups. Between-group comparisons showed there was greater oxygen saturation in the group that performed the 80-repetition sets (all  $P < 0.05$ ). Changes in oxygen saturation levels in the vastus lateralis muscle were correlated with the RER reductions ( $\rho = -0.495$ ). Furthermore, The EMG outcomes showed correlations with the absolute RFD ( $\rho$  ranging from 0.363 to 0.566). We conclude that muscle activation and the microcirculation of the quadriceps muscles were differentially affected by the low and high workloads of the eccentric exercise.

## Oral presentations

### OP-PM53 Health & Fitness: Lifestyle II

#### THE EFFECT OF DIFFERENT EXERCISE TYPES ON BODY COMPOSITION IN YOUNG ADULTS

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**Background.** Despite the widely accepted benefits of exercise on chronic disease risk and mortality, there remains controversy on the role of exercise in weight loss and weight management. The purpose of this study was to examine the effect of different exercise types on measures of adiposity across different fat categories. **Methods.** A total of 348 young adults (49% male, 28±4 years), participating in an ongoing observational study, provided valid data over a period of 12 months. Fat mass (FM) and lean mass (LM) were measured via dual x-ray absorptiometry every 3 months. Percent body fat (BF) was calculated and used to differentiate between normal fat, overfat and obese. At each measurement time point participants reported engagement (min/week) in aerobic exercise, resistance exercise and other exercise during the previous 3 months. Change in exercise participation was calculated using mixed linear modelling. In addition, total physical activity level (PAL) was objectively assessed with the SenseWear Mini Armband. **Results.** Most participants (93%) reported some exercise participation during the observation period. Total exercise or specific exercise types did not significantly affect subsequent BMI after adjusting for sex, ethnicity, age and baseline values of adiposity and exercise. There was, however, a positive effect of total exercise on lean mass ( $p < 0.01$ ) and a negative effect on fat mass ( $p < 0.01$ ). Resistance exercise had a positive effect on lean mass ( $p < 0.01$ ) and a negative effect on fat mass ( $p < 0.01$ ) while aerobic exercise only affected fat mass ( $p < 0.01$ ). Any exercise type positively affected lean mass in normal fat participants ( $p < 0.04$ ). In overfat and obese participants fat mass was negatively affected by resistance exercise ( $p \leq 0.02$ ) but not by aerobic exercise ( $p \geq 0.09$ ). Additionally adjusting for PAL did not change the previously reported results. **Conclusion.** Despite the limited effects on BMI, exercise induces positive changes in body composition. Exercise increases lean mass in normal fat participants while it reduces fat mass in overfat and obese adults. This group may benefit particularly from resistance exercise due to potential problems with achieving a sufficient intensity during aerobic exercise.

#### ADULT PARTICIPATION IN PHYSICAL ACTIVITY AND MUSCLE STRENGTHENING EXERCISES: RESULTS FROM THE AUSTRALIAN NATIONAL NUTRITION AND PHYSICAL ACTIVITY SURVEY

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**Introduction** The World Health Organization physical activity guidelines recommend that adults aged 18-64 years do ≥150 minutes of moderate to vigorous-intensity physical activity (MVPA) and ≥2 sessions of muscle strengthening exercises (MSE) per week (WHO, 2010). However, population studies rarely report on the prevalence of adults meeting the combined MVPA-MSE recommendations. This paper reports the prevalence and sociodemographic variations in recommended MVPA-MSE participation among Australian adults. **Methods** Data were drawn from the Australian Bureau of Statistics, National Nutrition and Physical Activity Survey and were collected by face-to-face interviews between May 2011 and June 2012. Physical activity was assessed using the previously validated Active Australia Survey (Brown et al., 2004). To assess MSE levels participants were asked if they did MSE in the last week and, if so, how many times they did this. The proportions participating in both ≥150 minutes MVPA and MSE ≥2 sessions were compared by selected socio-demographic and lifestyle variables. **Results** Data were available for 9,345 adults, aged 18-85 years. A total of 14.0% (95% CI 13.5-14.8%) met the MVPA-MSE recommendations. More males than females met the the guidelines (16.2 vs 12.2%,  $p < 0.001$ ). The prevalence of meeting MVPA-MSE guidelines declined with age, with the highest rate observed among those aged 18-24 years (24.5%), and the lowest rate among those aged 65+ years (6.6%). Higher prevalence rates were observed among those who rated their health as excellent (25.4%) and had high education levels (19.1%). Lower prevalence rates were found among those who rated their health as poor (4.1%), had low education levels (4.6%), and were current smokers (8.6%). **Discussion** The vast majority of Australian adults did not meet the combined MVPA-MSE recommendations. Given the use of self-report measures, these population estimates are likely to be conservative. Public health surveillance should continue to monitor combined MVPA-MSE levels. Moreover, future studies should investigate other potential determinants of MVPA-MSE participation, such as health awareness, motivation, perceived barriers, social and environmental support, and access to facilities to engage in MVPA-MSE. **References** World Health Organization (WHO). Global recommendations on physical activity for health. Geneva, CH: WHO; 2010. Brown WJ, et al. *J Sci Med Sport*;7(2):205-15; 2004.

## DEVIATION BETWEEN SELF-REPORTED AND MEASURED OCCUPATIONAL PHYSICAL ACTIVITY LEVELS IN OFFICE EMPLOYEES: EFFECTS OF AGE AND BODY-COMPOSITION

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University of Basel, Department of Sport, Exercise and Health, Basel, Switzerland University Hospital of the Friedrich-Schiller-University Jena, Institute of Psychosocial Medicine and Psychotherapy, Jena, Germany Introduction The decision to assess occupational physical activity (PA) levels via questionnaires or accelerometry relies on available resources and affects test validity and economy. Although self-reported data collection seems feasible and inexpensive, the obtained information could be biased by demographical determinants. Thus, we aimed at comparing self-reported and objectively measured sitting, standing, and walking time adjusted for age and body composition in office employees. Methods Thirty-eight office employees (8 males, 30 females, age: 40.8±11.4 years, BMI: 23.9±4.2 kg/m<sup>2</sup>) were equipped with height-adjustable desks (HAWD). They were asked to estimate their sitting, standing, and walking time using the Occupational Sitting Physical Activity Questionnaire (OSPAQ). The ActiGraph wGT3X-BT was additionally employed to objectively measure individual physical activity profiles within one week. In order to compare subjectively and objectively measured data, intra-class correlations (ICC) and multiple pairwise t-tests were computed. Additionally, repeated measures analyses of variances (ANOVA) were calculated including age- (<39 years of age vs. >39 years of age) and BMI-groups (underweight, normal weight, overweight) as independent factors. Additionally, Bland-Altman-plots were created in order to evaluate heteroscedacity and the amount of over- and underestimation of self-reported PA assessment. Results The correlation between self-reported and objectively measured PA levels was low for walking: (ICC: 0.04), moderate for sitting (ICC: 0.51) and standing (ICC: 0.64). Self-reported data yielded a significant underestimation of occupational standing time (13.3% vs. 17.9%,  $p < .01$ ) and an overestimation of walking time at work (12.7% vs. 5.0%,  $p < .01$ ). Large interaction effects between "age" and "measurement" of standing time ( $F = 6.0$ ,  $p = .02$ ,  $\eta^2 = .14$ ) and BMI group and measurement of walking time were found ( $F = 3.7$ ,  $p = .04$ ,  $\eta^2 = .17$ ). Especially, older employees (> 39 years) underestimated their standing time, while underweight workers (BMI < 20 kg/m<sup>2</sup>) overestimated their walking time. No significant effects occurred for sitting time. Discussion Self-reported physical activity data differ from objective data. Demographic variables seem to affect the amount of self-reported misjudging of physical activity levels. In order to improve the validity of self-reported data, subjective and objective measures from larger representative samples could be used to develop a correction formula for the economic assessment of physical activity by subjective measures.

## OBJECTIVELY MEASURED PHYSICAL ACTIVITY IN A WEB-BASED INTERVENTION ON PERSONALIZED NUTRITION: FINDINGS OF THE FOOD4ME STUDY

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Marsaux, C.1; Celis-Morales, C.2; Woolhead, C.3; Fallaize, R.4; Kolossa, S.5; Navas-Carretero, S.6; Tsigirioti, L.7; Surwillo, A.8; Hoonhout, J.9; Goris, A.10; Walsh, M.3; Manios, Y.7; Traczyk, I.8; Martinez, J.A.6; Lovegrove, J.A.4; Daniel, H.5; Gibney, M.5; Mathers, J.C.2 and Saris, W.H.M.1, on behalf of the Food4Me Study. 1:Maastricht University, The Netherlands, 2:Newcastle University, UK, 3:University College Dublin, Ireland, 4:University of Reading, UK, 5:Technische Universität München, Germany, 6:University of Navarra, Pamplona, Spain, 7:Harokopio University of Athens, Greece, 8:National Food & Nutrition Institute, Warsaw, Poland, 9:Philips Research, Eindhoven, The Netherlands, 10:Philips Consumer Lifestyle, Amsterdam, The Netherlands Introduction Physical inactivity is a leading risk factor for mortality. Several web-delivered physical activity (PA) interventions have reported positive behavioral outcomes, but evidence supporting the maintenance of PA changes is lacking; larger studies featuring interactive technologies are needed. The Food4Me study was a European web-based randomized controlled trial investigating whether a personalized intervention is more effective than the conventional "one size fits all" approach in changing nutritional and PA behaviors. Methods 1,607 participants from 7 European countries were randomly assigned to either a control or 3 personalized nutrition (PN) groups. PA was measured objectively (TracmorD accelerometer, Philips) during the 6-month intervention. Controls were given general PA advice, whereas PN groups received personalized PA advice at several time points. Changes in PA patterns were analyzed at months 3 and 6 of the intervention. Results At baseline, participants in the Food4Me study had relatively high PA levels (PAL), men being slightly but significantly more active than women ( $1.75 \pm 0.02$  vs.  $1.72 \pm 0.01$ , mean  $\pm$  95%CI;  $p < 0.05$ ); however 60% of women and 42% of men did not meet the WHO recommendation to accumulate weekly 150 minutes of moderate-equivalent PA (MEPA) in 10-min bouts. Adherence differed significantly by country for women and was lowest in Greece. Preliminary analyses show a significant increase from baseline in MEPA at month 3 for both control ( $62.6 \pm 30.6$  min/wk, mean  $\pm$  95%CI;  $p < 0.001$ ) and PN groups ( $46.4 \pm 16.3$  min/wk, mean  $\pm$  95%CI;  $p < 0.001$ ), but not at month 6. No significant differences in PA between PN and control groups were found. Compliance in wearing the accelerometer decreased markedly during the study; only half of participants had sufficient valid data at month 6. Conclusions Using accelerometers to assess PA is feasible in a web-based intervention study. Both conventional and personalized approaches effectively increase MEPA in European adults, but long-term engagement of participants is a challenge. Contact c.marsaux@maastrichtuniversity.nl

## STUDY ON INNOVATIONS OF SPORT FOR ALL MANAGEMENT IN CHINA

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Introduction After the Beijing Olympics, the Chinese government has been attaching greater importance to sport for all development. The opening date of the Beijing Olympic Games has been named as the "National Fitness Day". The first administrative regulation on the development of national fitness undertaking-"Regulations on National Fitness"-was issued, and the National Fitness Program (2011-2015) was formulated. The past few years have witnessed big progress in the development of sport for all, but some problems still exist. For example, more and more of the Chinese population is becoming overweight and elderly, and the physical conditions of young people are constantly declining. To address these issues, the sport for all administration in China has been carrying out a series of innovative initiatives. Methods This paper tries to summarize and analyze the measures and benefits of these innovations. The methods of literature research, expert interviews and comparative analysis are applied in this paper. Results Firstly, from the conceptual perspective, the focus of Chinese government has turned from mere establishment of sports facilities to comprehensive provision of sports public service. Secondly, the management pattern has been innovated. The sport for all development used to rely on government bodies. Now the efforts of governments, enterprises and social sectors have all been encouraged. Thirdly, the ways of managing sport for all programs have been different. The sport for all administration has been putting more attention on formulating policies and regulations rather than

directly organizing sports activities. Discussion As a result of these innovative initiatives, the public sport awareness in china has been increasing remarkably in recent years. The facilities for sport for all have been significantly improved and a more energetic mechanism of sport for all has been established. And lots of Olympic champions and world champions have been encouraged to participate in sport-for-all voluntary service. To sum up, the management of sport for all in China has been going through a lot of innovations after 2008 Olympics. And Beijing's bidding for the 2022 Winter Olympics will further push forward the national fitness undertaking to a new stage. References The State Council of China. (2009) Regulations on National Fitness. People's Publishing House, Beijing. Dai Jian, Shen Jia. (2014) Blue Book of Sport for All, 28-46. Social Sciences Academic Press, Beijing. Yang Xiaoming. (2014) Study on Coordinated Development of Sport for All at Urban and Rural Areas, 2-20. Shanghai University Press, Shanghai. The State Council of China. (2011) National Fitness Program (2011-2015).

## Oral presentations

### OP-PM55 Health & Fitness: Obesity

#### EFFECTS OF LIFESTYLE INDUCED WEIGHT LOSS ON MAXIMAL FAT OXIDATION

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Do not insert authors here! Introduction Maximal fat oxidation (MFO) is increased after an exercise-intervention at low-moderate intensities (1), whereas weight loss decreases MFO (2). Exercise in combination with diet induced weight loss is a common clinical intervention for the treatment of obesity. The aim of this longitudinal study was to examine whether MFO is enhanced with intensive lifestyle intervention (ILI) and at 3 months follow up. We hypothesized that the increased physical activity and hypocaloric diet would enhance MFO in obese subjects. Methods Obese participants (BMI:  $37 \pm 2$  kg/m<sup>2</sup>) enrolled in a 12-week ILI were recruited to the study. The ILI consisted of daily exercise (1-3 hrs.) of different intensities and a hypocaloric diet composition according to Nordic Nutritional Recommendations (CHO: 45-60%, Fat: 25-40%, Protein: 10-20%). Measurements were performed before ILI (B) and right after ILI (A) and again after 3 months of free living (3 MTH). MFO was determined from measurements of gas exchange using indirect calorimetry during a progressive, graded exercise test on a cycle ergometer until RER > 1.0 as previously described (3). After a 1 min break graded exercise was continued until exhaustion to determine VO<sub>2</sub>max. Results Participants (n = 46) were divided in two groups. One group who had lost >10% of initial body weight (WL; n = 23,  $16 \pm 1\%$ ) and the other who had lost <10% of initial body weight at 3 MTH (NL, n = 23;  $5 \pm 1\%$ ). Both groups achieved significant weight loss from B to A ( $p < 0.001$ ,  $11 \pm 1\%$  and  $7 \pm 1\%$ , respectively). VO<sub>2</sub>max (l/min) improved from B to A (avg.  $2.8 \pm 0.2$  and  $3.0 \pm 0.1$ ) and decreased during follow up (avg.  $2.6 \pm 0.2$ ). There was no difference in VO<sub>2</sub>max and MFO between groups at any time. MFO (g/min) was unchanged after ILI (B:  $0.48 \pm 0.04$  and  $0.54 \pm 0.03$ ) and (A:  $0.44 \pm 0.03$  and  $0.42 \pm 0.04$ ) and decreased ( $p < 0.001$ ) at 3 MTH ( $0.39 \pm 0.03$  and  $0.32 \pm 0.04$ ) in WL and NL, respectively. Discussion In the present study the difference in weight loss between groups did not influence the MFO or the increase in VO<sub>2</sub>max after ILI or significantly influence the magnitude of decrease observed in both VO<sub>2</sub>max and MFO after 3 months follow up. The unchanged MFO after ILI was in contrast to our proposed hypothesis and we speculate that the negative energy balance induced by ILI may attenuate the effect of increased physical activity. References 1) Mogensen et al. (2009). Diabetes, Obesity and Metabolism, 11(878-83) 2) Van Aggel-Leijssen et al. (2001). American Journal of Clinical Nutrition, 73(523-31) 3) Achten et al. (2002). Official Journal of the American College of Sports Medicine (92-97) Contact: camilaskovborg@sund.ku.dk

#### CUT-OFF POINTS OF HEALTH-RELATED FITNESS ASSOCIATED WITH METABOLIC SYNDROME IN KOREAN MEN AND WOMEN

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Introduction Cardiorespiratory fitness (CRF) is known to attenuate the risk of chronic conditions such as metabolic syndrome (MetS), cardiovascular disease (CVD), and type 2 diabetes. Thus, the cut-off points of CRF associated with health has been reported for men. However, the minimal thresholds of other health-related fitness components including muscular fitness for health have been limited, specifically for women. Therefore, the purpose of this study was to determine the thresholds of associated with MetS in Korean men and women. Methods A total of 1,378 adults (54.6% women) between 19 and 64 years participated in this study. All the participants performed health-related fitness (HRF) of Korean National Fitness Award Program (KNFA) tests, which composed of CRF (maximal oxygen uptake, VO<sub>2</sub>max), grip strength, sit-ups, and, sit-and-reach. FasMetS was defined as the NCEP ATP-III criteria. Using HRF and the MetS as the criterion, receiver operating characteristic (ROC) curves analyses were used to identify cut-off points for HRF. Relative risk Results The cut-off points for HRF associated with the MetS were as follows: 39.33ml/kg/min (11.2 METs) for CRF, 53% for grip strength, 38 rep for sit-ups, 9.5cm for sit-and-reach, and 28.95ml/kg/min (8.3 METs) for CRF, 41.29% for grip strength, 17 rep for sit-ups in Korean men and women respectively. And, the odds ratio for the over CRF thresholds were 0.32 (95%CI: 0.178-0.573) for Korean men and 0.50 (95%CI: 0.289-0.864) for Korean woman when compared with the under CFR thresholds, independent of age, smoking, alcohol intake and body mass index. Discussion This study is the first to identify thresholds of HRF associated with an increased likelihood of MetS in women as well as men. In the study CRF and muscular fitness were significantly related to the prevalence of MetS in men and women. In our ROC analysis, the optimal CRF threshold associated MetS was 11.2 METs in men, which is similar to ones by Kawakami et al (2014) and Katzmarzyk et al. (2007), 10.8 METs and 11.3METs, respectively. This study was designed to provide the cut-off points of HRF throughout adulthood even though fitness is known to decrease with aging. Since this is the first year of the KNAF study, we plan to identify age- and sex-specific thresholds for HRF. Reference Katzmarzyk PT, Craig CL, Gauvin L. (2007). Diabetologia 50,538-544. Kawakami R, Sawada SS, Matsushita M, Okamoto T, Takamoto K, Higuchi M, Miyahi M. (2014). J Epidemiol, 24(1), 25-30.



## IMPROVEMENT IN QUALITY OF LIFE AFTER INTENSIVE LIFESTYLE INTERVENTION IS RELATED TO MAINTENANCE OF WEIGHT LOSS

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**Introduction** Obesity can impact negatively on physical health, psychosocial functioning and emotional well-being (1). Intensive lifestyle interventions (ILI) are one approach to combat obesity and our aim was to unravel if weight loss (WL) maintenance 3 months after ILI concur with improvements in quality of life (QoL). We hypothesized that individuals who had a weight loss of >10 % of body weight 3 months after an ILI, would have superior improvements in QoL compared to those who lost <10 %. **Methods** This ILI was undertaken at Usherup Folk high school that runs ILIs of 10-14 weeks that aim to change the dietary habits, physical activity patterns and cognitive understanding of being obese. 60 participants answered a validated questionnaire; Impact of Weight on Quality of Life-Lite (IWQOL-Lite) (2) before and after the ILI and after returning to normal life for 3 months. 44 participants (BMI 37.1 ± 1.5 kg/m<sup>2</sup>) completed the questionnaires. Statistical analysis was performed by 2-way ANOVA (Sigmaplot 12.0) **Results** Based on the relative WL from start to 3 months after the ILI, two groups were established; a WL group (13 w, 9 m) lost > 10 % (13.6 ± 1.0 kg) and a weight regain (WR) group (16 w, 6 m) lost <10 % (6.8 ± 0.6 kg) of body weight. Total score in QoL showed that the WL group (+12.7 ± 2.1%) had a significantly (p<0.001) improved QoL 3 months after the ILI compared the WR group (+5.2 ± 1.6%). In the subcategories of the IWQOL-lite Physical function, Self-esteem and Work there were tendencies towards a difference (+16.9 ± 3.1 vs. +8.5 ± 2.5 % (p=0.08), +23.1 ± 3.1 vs. +10.9 ± 3.2 % (p=0.08) and +15.6 ± 4.8 vs. +1.5 ± 2.4 % (p=0.02)) in WL and WR, respectively. Furthermore, a significant correlation (r<sup>2</sup>= 0.18, p<0.01) was found between relative WL and improvement in QoL 3 months after ILI. **Discussion** In line with our hypothesis subjects who maintain a WL of > 10 % of body weight 3 months after an ILI are rewarded with improvements in QoL compared to those who do not maintain a 10 % WL. The study emphasizes that factors such as physical function, self-esteem and functions in work contexts are interrelated with the maintenance of lifestyle changes and weight loss. Whether these factors are also interrelated with weight loss maintenance over a longer time period still needs to be investigated. **Reference** 1) Danish-Health-and-Medicines-Authority (Updated March 2003) "National plan towards morbid obesity – solutions and perspectives" (In Danish) 2) Koloitkin et al. (2001). Development of a brief measure to assess quality of life in obesity. *Obes Res*: 9, 102-11. Contact Malene@sund.ku.dk

## GASTRIC BYPASS PATIENTS DO NOT CHANGE EXERCISE HABITS AFTER SURGERY

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**Introduction** Roux-en-Y gastric bypass (RYGB) leads to a major weight loss in severely obese patients and decrease the risk for developing type 2 diabetes, cardiovascular disease and premature death. Regular exercise has the same beneficial traits as weight loss and will further decrease these risks. Since most patients that undergo RYGB remain obese after the surgery-induced weight loss, regular exercise should be part of a healthier lifestyle. The primary outcome of the present study was the change in cardio-pulmonary fitness after RYGB in severely obese patients. **Methods** Thirty-four (10M/24F, BMI 43 ± 1 kg/m<sup>2</sup>, age 40 ± 2 yrs) subjects scheduled for RYGB had body composition (DXA-scan) and cardio-pulmonary fitness (incremental bicycle test to exhaustion) assessed and completed questionnaires regarding physical activity and function (SF-36 and CAMB (1;2)) twice before (A and B) and 4 (C) and 18 (D) months after surgery. Data was analyzed with mixed-model ANOVA with least squares post hoc test followed by a Tukey-Kramer adjustment. **Results** Cardio-pulmonary fitness (A: 21 ± 1, B: 22 ± 1, C: 26 ± 1 and D: 29 ± 2 ml O<sub>2</sub>/min/kg body weight, p < 0.001) increased with weight loss. However, maximal oxygen uptake (A: 2713 ± 128, B: 2711 ± 125, C: 2584 ± 128 and D: 2609 ± 189 ml O<sub>2</sub>/min, p = 0.02) was lower at C and D compared to B. The number of patients that felt very limited in performing strenuous activities (e.g. running, heavy lifting, strenuous sports) decreased (A: 72 %, B: 54 %, C: 18 %, and D: 4 %, p < 0.001) with weight loss. Finally, self-reported weekly amount of time spent on exercise (e.g. running, soccer, tennis, aerobic) (A: 1.5 ± 0.4, B: 1.5 ± 0.4, C: 1.5 ± 0.4 and D: 2.2 ± 0.5 hrs/week) did not change after RYGB. **Conclusions** After RYGB cardio-pulmonary fitness increases as weight is lost. This decreases the experience of limitations to perform exercise. Nevertheless, questionnaire data and the slight decrease in maximal oxygen uptake show that RYGB patients do not adopt new exercise habits the first years following surgery. **References** 1. Bjorner JB, Thunedborg K, Kristensen TS, et al. The Danish SF-36 Health Survey: translation and preliminary validity studies. *J.Clin.Epidemiol.* 1998;51(11):991-999. 2. Avlund K, Osler M, Mortensen EL, et al. Copenhagen Aging and Midlife Biobank (CAMB): an introduction. *J.Aging Health* 2014;26(1):5-20. Contact For further information please contact Michael Taalo Lund MD, PhD, e-mail: michaeltl@sund.ku.dk

## Oral presentations

### OP-BN09 Biomechanics Mixed session

#### THE MECHANICAL POWER OUTPUT – VELOCITY CURVE OF THE VELOTRON CYCLING ERGOMETER, AND ITS RELEVANCE FOR CYCLING PERFORMANCE AND PACING RESEARCH.

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**THE MECHANICAL POWER OUTPUT – VELOCITY CURVE OF THE VELOTRON CYCLING ERGOMETER, AND ITS RELEVANCE FOR CYCLING PERFORMANCE AND PACING RESEARCH.** 1University of Essex, School of Biological Sciences, Centre of Sport and Exercise Science, Colchester, United Kingdom. 2AlbertWOT, Hilversum, The Netherlands. **Introduction** Interaction with the environment is an important determinant of pacing behaviour in athletes (Smits et al., 2014). The Velotron Racermate Dynafit cycle ergometer is introduced to resemble real life situations by allowing on screen opponents, gear changes and the creation of windy and/or hilly conditions. Furthermore, it is claimed that the Velotron incorporates the non-linear relation between mechanical power output and velocity as is apparent in road cycling. This biomechanical aspect is essential in determining successful pacing behaviour and is of influence on the decisions that athletes make during races regarding their energy expenditure (de Koning et al., 1999; Hettlinga et al., 2012). The present study aimed to determine the relation between mechanical power output and velocity of the Velotron cycling ergometer. **Methods** To determine the mechanical power output - velocity curve of the Velotron, a range of velocities and accompanying power outputs were evaluated. The Velotron was propelled using

a calibration rig to simulate a continuous pedalling cadence of 90 RPM. The rig was attached to the crank of the Velotron at the position of the left pedal via a counterbalanced double universal joint. By upshifting gears, while keeping the cadence on 90 RPM, 18 different stages were tested. Power output and speed data were collected over 30 seconds of steady state cycling per stage, resulting in the power (PO) velocity (v) curve. Trendlines were fit and coefficients of determination were obtained. Results 18 Unique samples were taken (PO(W) - v(kmh); 29-14, 35-15, 44-17, 56-19, 63-20, 72-22, 83-23, 100-25, 121-27, 149-30, 189-32, 226-25, 274-38, 355-41, 416-44, 489-47, 601-50, 744-54). Best fits were obtained using a power fit trendline, evidencing the non-linear character of the power velocity curve of the Velotron (PO=0.0453v<sup>2</sup>4,078, r<sup>2</sup>=0.997). Discussion The range of velocities and accompanying power outputs tested on the Velotron showed a clear non-linear curvature, as is apparent in real life outdoor cycling performance. Our findings support the Velotron as a realistic and valid cycle ergometer to study cycling performance and pacing behaviour in a laboratory setting. References Smits B, Popping G, Hettinga F. (2014) *Sports Med*, 44(6) 763–775. de Koning J, Bobbert M, Foster C. (1999) *J Sci Med Sports*, 2(3) 266–277. Hettinga F, de Koning J, Hulleman M, Foster, C. (2012) *Br J Sports Med* 46(1) 30-35. Contact fjhett@essex.ac.uk

## ENERGY COSTS AND LEG MUSCLE ACTIVITIES IN ASCENDING STAIRS

Halder, A.1, Kuklane, K.1, Gao, C.1, Miller, M.1, Noren, J.2, Delin, M.3, Lundgren, K.1, Fridolf, C.1

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1: LU (Lund, Sweden), 2: BRIAB (Stockholm, Sweden), 3: DeBRAND (Stockholm, Sweden) Introduction Repetitive movements and continuous force production through lower limb muscles are required to ascend many flights of stairs on demand especially in an emergency situation. The purpose of this study was to determine the relationship of muscle activity to the oxygen uptake (VO<sub>2</sub>) and the development of leg muscle fatigue from real stair climbing activities. Methods A total of twelve healthy adults (8 men and 4 women) with mean age (±SD) 35.6 (± 9.7) volunteered in the study. Subjects were encouraged to climb 12 floors with 268 steps in their self-selected pace. Oxygen consumption, heart rate (HR) and surface electromyography (sEMG) of the thigh Vastus Lateralis (VL), Vastus Medialis (VM) and Gastrocnemius Lateralis (GL), Gastrocnemius Medialis (GM) from calf muscles as well as ascending speed were recorded. Results The average total time required about 162 (± 38.9) s to reach to the top 12th floor while VO<sub>2</sub>max reached to about 3.0 (± 0.7) l/min corresponding to 40.5 (± 6.5) ml/kg/min. The average HRmax peaked to 170 beats/min and max metabolic rate calculated about 553 W/m<sup>2</sup> from the participants. The main sEMG root mean square (RMS) average median amplitudes (P<0.05) results from GL; RMS average and area amplitudes of (both P<0.02) GM muscles reduced significantly in one-way ANOVA test. Moreover, RMS amplitudes of both thigh and calf muscles showed anticipated progressive reduction at the end. The average climbing speed dropped gradually from .95 to .73 m/s. Discussion However, none of the leg muscles frequency analysis showed significance decrease, thus no indication of muscle fatigue in this self-controlled short duration repetitive activities. This may suggest that subjects tend to adopt some coping strategies that might have changed the sEMG signals (Bigland-Ritchie et al., 1981). The results also showed that sEMG amplitudes reduction might be related to the gradual speed reduction during climbing and to the decrease of leg muscles force production capabilities (Cifrek et al., 2009). Stair ascent is a physically challenging task in terms of leg muscle force production and cardiorespiratory capacities. This may be possible to manage for a shorter duration with tolerable amount of physical stress under self-controlled situations. Future studies with more number of floors and longer ascending duration to evaluate physical evacuation capacity and muscle fatigue are needed. References Bigland-Ritchie B, Donovan EF, Rousso CS (1981). Conduction velocity and EMG power spectrum changes in fatigue of sustained maximal efforts. *J Appl Physiol*, 51:1300-1305. Cifrek M, Medved V, Tonković S, Ostojic, S. (2009). Surface EMG based muscle fatigue evaluation in biomechanics. *Clinical Biomechanics* (Bristol, Avon), 24(4), 327-340. Contact Email: Amitava.halder@design.lth.se

## MOTOR UNIT FIRING RATE RESPONSES TO ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE

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Introduction: Exercise-induced muscle damage (EIMD) has been associated with unaccustomed exercise, particularly eccentric muscle contractions (Warren et al, 1999). EIMD manifests with delayed onset muscle soreness (DOMS) and impaired muscle function. Additionally, decreased motor unit (MU) recruitment threshold and increased MU synchronization, suggesting a centrally mediated response to EIMD (Semmler, 2014). Aim: To investigate centrally driven strategies in MU recruitment following EIMD, specifically concerning MU firing rate and common drive. Methods: Healthy male subjects (mean age 26.2 years) (n=14), performed repeated sets of 12 eccentric knee extension contractions, until failure, on an isokinetic dynamometer. Range of movement and eccentric velocity were 90° and 60°/sec, respectively. Maximal voluntary contraction (MVC), rate of torque development (RTD) and perceived muscle soreness was recorded pre- and 48 hours post- eccentric exercise, as indicators of EIMD. High density electromyography (HD-EMG) was captured, on each day, from the vastus lateralis, during a 12s submaximal (60% of MVC) isometric knee extension. HD-EMG captures were decomposed using a precision decomposition algorithm (PD III), as described by Nawab et al (2010), to detect individual MU firings. The cross-correlation between recruited MUs was compared between pre- and post-exercise as an indicator of the level of common drive to MUs. Identified MUs were also grouped into tertiles, to establish early, middle and late recruitment. Mean MU firing rates within each tertile were compared pre- and 48 hours post-eccentric exercise. Results: MVC and RTD were 28% (p<0.001) and 57% (p<0.001) lower 48 hours post-exercise, compared to pre-exercise. These functional impairments were accompanied by a 50% (p<0.05) increase in perceived muscle soreness. There was no significant alteration in the total number of recruited MUs, detected by HD-EMG, pre- vs. post-exercise. The mean firing rate of late recruited MUs (third tertile) significantly (p<0.05) declined 48 hours post-eccentric exercise. While the MUs located in the second (middle) tertile showed a non-significant (p=0.071) tendency towards slower firing rate 48 hours post-exercise. Although peak cross correlation of recruited MUs did not differ significantly between time points, mean cross correlation of MUs was 41% (p<0.001) higher 48 hours post-exercise. Discussion: This study has shown that 48 hours following EIMD, in the knee extensors, the firing rate of later recruited MUs is impaired, despite force output being maintained. In response, common drive to motor units is increased, as indicated by greater mean cross correlation of MUs. References: Nawab, SH, Chang, SS, De Luca, CJ. (2010). *Clinical Neurophysiology*, 121(10), 1602-1615 Semmler, JG. (2014). *Acta Physiologica*, 210, 754–767 Warren, GL, Lowe, DA, Armstrong, RB. (1999). *Sports Medicine*, 27(1), 43-59

## Oral presentations

### OP-SH25 Sociology (Sport and gender)

#### TRANSCENDING GENDER HIERARCHIES? YOUNG PEOPLE AND FLOORBALL IN SWEDISH SCHOOL SPORT

Larneby, M.

*Malmö University*

In Swedish organized team sport boys and girls mainly train and compete separately. As Messner (2002) argues, this often reproduces traditional gender hierarchies within sport, in which boys are favored and girls undervalued. However, as a relatively new sport, floorball has "good opportunities to be depicted in a more equal way" (Ljunggren 2013:10). In contrast to floorball practiced during leisure time, in school sport it is often performed in mixed-sex groups. The aim of this study is to explore and discuss young people's construction and displaying of gender in a mixed-sex floorball group, and in what way gendered power relations are exercised within this group. Methodology and theory An ethnographic approach was used to access voices, attitudes and actions on and off the floorball pitch (Ennis & Chen 2012). Young teenagers attending floorball lessons at a sport school from 7th to 9th grade were observed and interviewed. Lorber's (1994) theory of gender as a social institution was used to analyze and interpret their expressions and actions, attitudes and notions of sport. Results The mixed-sex sport setting seems to actualize an unspoken and unquestioned need to dichotomize and construct distinct groups of boys and girls (cf. Lorber 1994). In the studied group, the teenagers talk of themselves as "we" vs the "boys/girls". The girls seem to emphasize that they empower themselves by improving their athletic skills together with boys, and that their strength and ambitions are appreciated. Yet, they are also patronized in various ways by their male peers. The boys reproduce an orthodox masculinity as they perceive that the girls threaten the boys' position in sport. This is complex, as they similarly challenge this masculinity by appreciating the girls as skilled training peers. Conclusion When boys and girls attend a sport school it may be the first time they play floorball with representatives of the other sex, as training during leisure time is usually gender separated. Although the boys and girls constantly emphasize differences due to gender, they strive towards a uniform level of skills and ideal way of play too. Gender seems to lose significance in this common strive for similarity. Despite this, gendered power relations set an agenda based in a notion underlining that "boys' way to play floorball" is the ideal. Thus, a traditional gender hierarchy is rather reproduced than transcended. References Ennis, C. and S. Chen. 2012. Interviews and focus groups. In *Research methods in physical education and youth sport*. Edited by: K. Armour and D. Macdonald. New York: Routledge. Ljunggren, J. 2013. The history of the Swedish floorball miracle. *Svensk idrottsforskning*. 4: 8-12. Lorber, J. 1994. *Paradoxes of gender*. New York: Yale university press. Messner, M. 2002. *Taking the field: women and men in sports*. Minneapolis: University of Minnesota Press.

#### THE ROLE OF EMOTIONAL RELATIONS IN ADVANCING GENDER EQUALITY IN SPORT GOVERNANCE

Adriaanse, J.

*University of Technology Sydney*

Introduction Women remain largely under-represented in the governance of sport organisations according to the Sydney Scoreboard global index for women in sport leadership (International Working Group on Women and Sport, 2015). Most research on gender and sport governance focuses on the concept of power. Central to this study was the concept of collaboration between and within men and women. Theoretically the study draws on Connell's (2009) concept of a gender regime, a pattern of gender relations characterised by four interwoven dimensions of social life: production, power, emotions and symbolism. The aim of this paper is to investigate the role of collaborative/emotional relations in advancing gender equality in sport governance. Methods An audit of the gender distribution on boards of 56 Australian National Sport Organisations (NSOs) was conducted followed by 26 semi-structured interviews with CEOs and board directors of five NSOs. Structured on Connell's four-dimensional gender model, case studies with results for each of the five NSOs were drafted and gender regimes identified. This presentation reports on two case studies: Sport boards C and E. Results Sport board C exhibited a gender regime of masculine hegemony in transition. This regime was associated with divisive and hostile emotional relations between and within men and women directors providing limited prospect for gender equality in sport governance. Conversely, sport board E showed a regime of gender mainstreaming in progress which was associated with cohesive and supportive emotional relations on the board. This regime offered positive prospects for gender equality in sport governance. Discussion The study's finding that divisive and hostile emotional relations inhibited prospects for gender equality on sport boards corresponds with results of a 'drop-out' study in German sport organisations (Pfister & Radtke, 2009). Further, the current study found that cohesive and supportive emotional relations were associated with a regime of gender mainstreaming in progress but they need to operate in conjunction with other gender dimensions to achieve gender equality in the governance of sport organisations. The other dimensions were gender parity in numbers (power relations), women and men sharing the most influential roles such as board chair and CEO (production relations), and the adoption of gender equality as an organisational value (symbolic relations). References Connell, R. (2009). *Gender*. Cambridge, UK: Polity. International Working Group on Women and Sport. (2015). *Sydney Scoreboard*. Retrieved 12 February 2015, from <http://www.sydneyscoreboard.com/> Pfister, G., & Radtke, S. (2009). Sport, women and leadership: Results of a project on executives in German sports organisations. *European Journal of Sport Science*, 9(4), 229-243.

#### THE IMPACT OF GENDER QUOTAS IN SPORT LEADERSHIP IN NORWAY

Sisjord, M.K., Fastang, K., Sand, T.S.

*The Norwegian School of Sport Sciences*

Do not insert authors here The impact of gender quotas in sport leadership in Norway. The paper focuses on gender representation on boards in the Norwegian Olympic and Paralympic Committee (NOC). NOC is the umbrella organization for the 55 individual sport federations. In 1990 the General Assembly of NOC passed paragraph, 2-4 in NOCs rule book, stating that the composition of members to executive boards, councils and committees shall be proportionate to the gender distribution among members, such however, that there shall be at least two representatives from each of the sexes. Annual reports from the sport federations reveal a progressive increase of women on the boards reflects the gender distribution of memberships. The paper highlights how the sport federations are dealing with the issue of gender representation based on qualitative interviews with representatives from 24 individual sport federations primarily with the secretaries general. The results are categorized according to: the awareness of the paragraph among administrators and leaders of

the federation, how the paragraph is put into practice, and particularly the efforts made with the purpose of promoting equal gender representation. The results show that 17 of the federations are aware of, and in general follow the paragraph. All of them follow the rule with regard to the composition of the board, and seven federations have developed specific initiatives in order to promote representation of the underrepresented sex. On the other hand, four federations are aware of the rule but struggle with following it in practice, not having made specific efforts for following it. The latter category includes the three federations apparently ignoring the rule. A couple of the interviewees even spoke against quotas. In the discussion of the results it will be shown that the larger federations are following the rule. The biased gender distribution in memberships in some federations will also be discussed. Furthermore, the results are discussed in relation to gender theory with particular reference to Connell's perspectives of the gender order in society and the concept gender regime.

### **DISTRIBUTIONAL LOGICS OF THE SWEDISH OLYMPIC COMMITTEE**

Hellborg, A.

*Malmö University*

**Introduction** The aim of this presentation is to map out and analyze the Swedish Olympic Committee's (SOC) financial distribution logics. In Sweden, SOC is a key financial actor for many Swedish athletes, others are sponsors and indirectly sport associations. Gender theory will be used as an analytical tool together with an age perspective. This study is part of my thesis which concerns three financial actors (SOC, Swedish sport associations and sponsors) within four different sports (soccer, curling, equestrian sports and golf). **Method** The study is based on interviews with the chair of SOC as well as information on SOC's website and interviews with two sport association representatives (soccer and curling). **Results** Preliminary results suggest that the main criteria for giving an athlete financial aid in the form of scholarships is their international competitive status and their chances of winning a medal at the Olympic Games. In practice, this means that the distribution between different sports can be skewed since some sports have many top athletes while other sports have none. There are no gender equality policies guiding SOC's decisions that affect the distribution in a gender equal manner. There is, however, a logic based on a conception of age. When two equally skilled athletes compete for the same spot the SOC prefer to support the younger athlete. Finally the athletes must be able to train and compete, which means that athletes will not receive financial support during rehabilitation or parental leave etcetera. **Discussion** According to Ridgeway women are often overlooked and viewed as less competent than men (2011; compare Hellborg & Hedenborg 2015). There's a risk that these stereotypical views could affect the distribution of SOC's means if they don't have a gender equality policy. Women may also be more affected than men by disruption in financial support when starting a family since pregnancy affects their ability to train and compete. This is also something that SOC needs to consider as an equality matter. Concerning age, it is problematic to assume that a younger athlete will have a longer development curve since athletes' peaks can alter and some bloom later than others. In some sports, like curling, golf and equestrian sports (which are included in this study), age average of top athletes are much higher than in for example football. **References** Hellborg, A.M. & Hedenborg, S (2015) "The rocker and the heroine: gendered media representations of equestrian sports at the 2012 Olympics" *Sport in Society* 18:2:248 Ridgeway, C.L. (2011) *Framed by gender*. New York: Oxford University Press

### **EMANCIPATING MOVEMENTS: AN INVESTIGATION OF FEMALE PARTICIPANTS' EXPERIENCES OF FITNESS PRACTICES THROUGH COLLECTIVE MEMORY WORK**

Bladh, G.

*Lund University*

**Emancipating movements: An investigation of female participants' experiences of fitness practices through collective memory work** Bladh, Greta, Lund University, Sweden **Introduction** Research within social science has framed exercise by the ordinary individual as something enmeshed within the subject's negotiations of social structure and discourse as these practices are entangled within social structures of neoliberal expressions of consumerism and individualization (Smith-Maguire 2008, Dworkin 2001). In relation to this, the moving body has been caught as the protagonist of the new morals of health (Metzl 2010). Physical activity has also been comprehended as an emancipatory practice for women by means of transgressing gender stereotypical expectations. However, the results of former analytical work make clear certain constraints, such as a social construction of a glass ceiling in muscle development in women (Dworkin 2001), and the restraining relationship between athleticism and femininity (George 2005). This in turn has an impact on the way and where women exercise and engage in physical activity (Goerge 2005, Dworkin 2001). Hence, the aim of this study is to examine the constraining properties circumscribing female physical activity in an everyday setting of the gym by means of collective memory work and thus further illuminate the potential emancipatory qualities of practices of physical fitness of the female individual. **Methods** Exercise can be comprehended as an action within its narrative. Yet, how and why we tell a story are dependent upon a criteria of relevance, that is, our memories are censored through socialization (Haug 1987: 49). Therefore, by collectively analyzing written down memories of physical activities in a particular setting a critical light will be shed upon female physical fitness in an everyday setting. **Results/Discussion/Hypothesis** As this research process is its initial stage, this paper aims first and foremost to discuss the methodological approach towards a critical perspective regarding physical activity and fitness among women with an ambition to further the research within this area of study within sports science. **References** Dworkin, Shari L. (2001). "Holding back": Negotiating a glass ceiling on women's muscular strength. *Sociological Perspectives*, Vol. 44. No. 3 (Fall 2001): 333-350 George, Molly (2005). "Making Sense of Muscle: The Body Experience of Collegiate Women Athletes". *Sociological Inquiry*, Vol. 75, No. 3, August 2005, 317-345 Haug, Frigga et al (1999,1987). *Female Sexualization: A Collective Work of Memory*. Translated by Erica Carter, 2nd Edition. London: Verso Books Metzl, Jonathan M (2010). "Introduction", in *Against Health How Health Became the New Morality* (edited by Metzl, M. and Kirkland, Anna). New York and London: New York University Press Smith-Maguire, Jennifer (2008). *Fit for Consumption: Sociology and the business of fitness*. London: Routledge Contact: greta.bladh@hotmail.com

12:00 - 13:15

## Plenary sessions

### PS-PL04 INACTIVITY AND THE AGEING POPULATION

#### INCREASING PHYSICAL LEVELS IS THE KEY COMPONENT TO IMPROVING LIFELONG HEALTH AND WELL BEING

Blair, S.

*University of South Carolina*

Sedentary habits are highly prevalent in most countries of the world. In the U.S. approximately 25-35% of adults are inactive, meaning that they have sedentary jobs, no regular physical activity program, and are generally sedentary around the house and yard. Given that sedentary and unfit individuals are at approximately two-fold higher risk for many health conditions than those who are moderately active and fit, the population attributable risk (PAR) of inactivity is high. In the Aerobics Center Longitudinal Study (ACLS) the PAR for low fitness in more than 50,000 women and men followed for many years is 16-17% of deaths. This is far higher than other putative risk factors for mortality. For example, obesity accounts for 2-3% of deaths in the U.S. In the ACS, 27% of the deaths might have been avoided if none of the men had prevalent cardiovascular disease at baseline whereas 44% of the deaths might have been avoided if none of the men had been unfit. The independent relative risks for death are comparable for prevalent cardiovascular disease (RR=2.4) and for low fitness (RR=2.3). Over the past few decades we have largely engineered the need for physical activity at home, on the job, and during leisure-time out of the daily lives of most people in industrialized societies. To address the major public health problem of physical inactivity we will need to consider and evaluate societal, environmental, and individual approaches to making physical activity more common for more people more of the time.

#### PHARMACEUTICAL DRUG DEVELOPMENT IS THE KEY TO OFFSETTING AGE RELATED DYSFUNCTION AND CHRONIC DISEASE

Evans, W.

*Duke University and KineMed, Inc*

Sarcopenia is a universal phenomenon that results in an increased risk of disability, morbidity, and mortality. While the loss of skeletal muscle mass and function with age is inevitable, the trajectory of loss is highly variable. Regularly performed exercise, particularly resistance exercise, has remarkably positive effects on increasing strength and function in elderly people. Exercise can help to slow the rate of loss of muscle with advancing age and prevent disability and reduce morbidity and mortality. However, the large majority of elderly people do not exercise regularly and inactivity accelerates loss of muscle and function. Skeletal muscle has many roles, besides contractile function. It is the main source of insulin stimulated glucose disposal and serves as a metabolic reserve of amino acids during periods of stress and undernutrition. The pharmacological treatment of sarcopenia rather than exercise is unlikely, however, a new generation of anabolic therapies may be effective to treat the frail and weak elderly patients. Bed rest in older people is associated with a large loss of muscle in a very short period of time and this loss results in greatly reduced physical activity after returning home. Indeed, many older people are unable to return home after hospitalization due to loss of muscle and function. The loss of muscle and function resulting from hip fracture in elderly people occurs most rapidly in the initial period after surgery and rehab therapy is often ineffective in improving function. The use of pro-anabolic therapies either alone or with exercise to prevent immobilization atrophy in these patients has the promise of greatly improved outcomes associated with prevention or increased muscle loss. The use of pharmacological therapy can also improve muscle insulin sensitivity and stimulate protein synthesis, increase muscle blood flow in elderly people with peripheral artery disease and improve function. Anabolic therapies may also help to treat sarcopenic obesity by prevention muscle loss during weight loss in older people. The new generation of anabolic therapies include selective androgen receptor modulators, ghrelin, antagonists of the TGF-beta superfamily hold great promise for treating the most frail and those at greatest risk of late-life disability.





## e-poster

## PP-UD01

## Adapted Physical Activity

**IMPACT OF AN ADAPTED PHYSICAL ACTIVITY FOR PATIENTS WITH CHRONIC KIDNEY DISEASE**

Frih, B., Frih, A., Bensalah, R., Rjili, H., Bensalah, Z., Bendhia, N., Elmay, M., Hammami, M.

*LabNAFS-LR12E505 – Faculty of Médecine-Monastir (TUNISIE), Departments of Nephrology, Monastir Hospital (TUNISIE), Departments of MPR, CHU Monastir - (Tunisie).*

**Introduction** The success of dialysis treatment and survival of patients depends on several factors, which are mainly; the quality of life and the physical conditions of these patients **Objective:** To evaluate the effects of an adapted physical activity based on flexibility, strength and endurance exercises program. **Patients and methods:** A group of 30 hemodialysis patients recruited from the department of nephrology and hemodialysis. This group was following a physical activity program for a period of 12 weeks, 2 times a week. The evaluation is performed before and after the proposed protocol by two questionnaires: quality of life (SF36) and hospital anxiety and depressive scale (HAD), echocardiogram, electrocardiogram, spirometry, lipidic concentration and six-Minute walk Test (6MWT). **Results:** There was no undesirable event during rehabilitation sessions. The quality of life (physical and mental component) and anxious component (HAD) improved. The distance walked on the 6MWT has increased. The lipid profile was enhanced (HDL and LDL - cholesterol, triglyceride). **Discussion - Conclusion:** Designing an adapted physical activity is highly recommended for the patients with chronic kidney disease. This appears to be a safe and effective alternative for developing functional capacity, laboratory parameters and the psychological profile of hemodialysis patients.

**EFFECT OF BLOOD VOLUME ON PLASMA VOLUME SHIFT DURING EXERCISE**

Ogura, T., Oda, S., Kaida, K., Miyazaki, K., Kawabata, T.

*laboratory for environmental physiology for exercise*

**EFFECT OF BLOOD VOLUME ON PLASMA VOLUME SHIFT DURING EXERCISE** Ogura, T., Oda, S., Kaida, K., Miyazaki, K. and Kawabata, T. Kansai Univ. Graduate School of Health and Well-being (Japan) **Introduction** The maintenance of blood volume (BV) is an important factor for providing circulatory stability, thermoregulatory and maintaining performance during exercise. Hypovolemia from thermal dehydration or progressive pooling of blood in cutaneous blood vessels and the shifts in plasma volume (PV) reduces the central circulating blood volume (I). The aim of the present study is to assess the effect of BV on PV shift during exercise and BV - aerobic work capacity relationship in the difference of fitness levels in individual variations. **Methods** Thirteen healthy (Japanese professional football player) participated in the present study. Their mean (SEM) age, height, weight and peak oxygen consumption (VO<sub>2</sub>peak) were 27.4 (1.5) yr, 178.4 ( 2.6) cm, 71.3 (1.9) kg and 61.5 (1.1) ml kg<sup>-1</sup> min<sup>-1</sup>. Subjects rested in supine posture for 40 min. after the rest period, BV, cardiac output (CO) and stroke volume (SV) were measured by the pulse dye densitometry (DDG-2001, Nihon Kohden, Japan) using the dye Indocyanine green as the indicator in the supine position. And then subjects moved on the treadmill. **Results** The values of VO<sub>2</sub>peak per body weight was 61.5 (1.1) ml kg<sup>-1</sup> min<sup>-1</sup>. Maximal HR during graded exercise was 182.7 (1.6) beats min<sup>-1</sup>. The CO and SV at rest were 4.3 (0.10) L and 88.5 (1.85) ml. BV and PV in the supine posture were 64.7 (3.9) and 38.1 (2.4) ml kg<sup>-1</sup>, respectively. The percentage of changes in PV during graded exercise decreased gradually from 10.7 (0.6) % to 20.7 (0.7) % in exhaustion. The shifts in PV at the point of LT level averaged 16.4 (0.6) % and the range of the PV shift in individual variations were from 12.5% to 19.6%. **Discussion** The relationship of peak VO<sub>2</sub> with BV indicated a significant positive correlation between peak VO<sub>2</sub> and BV. It is well known that during dynamic exercise, BV tends to fall slightly due mainly to decreased PV in proportion to the exercise intensity. In the present study, during exercise PV decreased significantly from an average resting value of 2685.4 ml by 19.6% or 532.4 ml. The shifts in plasma volume at LT averaged 440.4 ml or 16.4% and the relationship of the shifts in PV at LT with total PV indicated a significant negative correlation. However, the relationship of the circulating PV, calculated from the shifts of PV at LT in individuals, with total PV and VO<sub>2</sub> at LT indicated a significant positive correlation between the circulating PV and total PV and VO<sub>2</sub> at LT. These results suggested that the strong positive relation between the shifts in PV and total PV and results in a maintenance of the circulating BV. **References** 1 Fortney SM, Nadel ER, Wenger CB, and Bove JR: Effect of acute alteration of blood volume on circulatory performance in human. *J Appl Physiol* 50: 292-298, 1981 Contact takakaw@kansai-u.ac.jp

**BLOOD VOLUME AND AEROBIC PERFORMANCE IN ELITE SOCCER PLAYER**

Kaita, K., Ogura, T., Miyazaki, K., Oda, S., Kawabata, T.

*Laboratory for environment physiology for exercise*

**BLOOD VOLUME AND AEROBIC PERFORMANCE IN ELITE SOCCER PLAYER** Kaita, K., Ogura, T., Miyazaki, K., Oda, S. and Kawabata, T. Kansai Univ. Graduate School of Health and Well-being (Japan) **Introduction** The maintenance of blood volume (BV) is an important factor for providing circulatory stability, thermoregulatory and maintaining aerobic performance in football game. Hypovolemia from thermal dehydration or progressive pooling of blood in cutaneous blood vessels and the shift in plasma volume (PV) reduces the central circulating blood volume. Under these condition, cutaneous vasoconstriction leads to excessive heat storage in heat stress. Increases in sweat rate and skin blood flow during exercise enhance heat dissipation and prevent hyperthermia. Hyperthermia itself has been suggested to limit aerobic performance. The aim of the present study is to assess the effect of BV on PV shift during exercise and BV-aerobic work capacity relationship in the difference of fitness levels in individual variations in elite football player. **Methods** We measured changes in plasma volume during exercise and blood volume in thirteen professional football players, attached to Japan football league. Blood volume was measured by the pulse Indocyanine green (ICG) dilution method (DDG-2001, Nihon Koden, Japan). Exercise intensity was increased stepwisely until voluntary exhaustion. Blood samples were collected at each stepwisely exercise intensity and at exhaustion. **Results & Discussion** It is well known that during exercise, BV tends to fall slightly due mainly to decreased PV in proportion to the exercise intensity (I). In the present study, in exercise PV decreased significantly from an average resting value of 2685.4 ml by 19.6% or 532.4 ml.



The mean values (SE) of peak VO<sub>2</sub> was 61.5 (1.1) ml kg<sup>-1</sup> min<sup>-1</sup>. BV and PV in the supine posture were 64.7 (3.9) and 38.1 (2.4) ml kg<sup>-1</sup>, respectively. The relationship of VO<sub>2</sub>peak with BV and PV indicated a significant positive correlation. The value of VO<sub>2</sub> at lactate threshold (LT) was 57.5 (1.5) ml kg<sup>-1</sup> min<sup>-1</sup>. The PV shift-LT averaged 440.4 ml or 16.4%. The relationship of the circulating PV, calculated from the PV shift-LT in individuals, with total PV and VO<sub>2</sub>-LT indicated a significant positive correlation. These results suggested that the strong positive relation between the PV shift and total PV, and results in a maintenance of the circulating BV. References 1. Kawabata, T. et al. (2004). *J Therm. Biol.* 29: 775-778. Contact Please send correspondence to: takashi KAWABATA takakaw@kansai-u.ac.jp

### LONG-TERM ENDURANCE EXERCISE IN MS PATIENTS – IMPACT ON QUALITY OF LIFE AND DEPRESSIVE SYMPTOMS IN RELATION TO BASELINE FATIGUE

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**Introduction** Quality of life (QoL) is substantially impaired in MS patients [1]. In addition to motor and balance disability fatigue and depressive symptoms (DS) also strongly contribute to QoL [2]. The long-term effects of aerobic endurance exercise on QoL and DS remain to be defined, in particular with reference to the baseline fatigue. **Patients and Methods** Prospective, non-randomized, observer blinded cohort study of 89 patients with relapsing-remitting MS and an EDSS of ≤ 3.5. Fatigue was measured by the Fatigue Severity Scale (FSS) with a defined cut-off value of ≥4.0 for a subgroup analysis of fatigue versus non-fatigue. QoL was determined by the SF-36 Health Survey and DS by a German version of the Center for Epidemiologic Studies Depression Scale (CES-D), the ADS-L. An individualized exercise intervention was performed for 12 months with follow-up examinations every three months. The data were explored by per-protocol analysis using ANOVA for repeated measurements. **Results** A significant reduced QoL for all subscales of the SF-36 ( $p < .05$ ) and the ADS-L ( $p < .01$ ;  $\eta^2 = .15$ ) was detectable in MS patients with fatigue in comparison to those without fatigue. However, a significant interaction effect over time was only discernible in the subscale 'general health perception' in patients with fatigue ( $p \leq .01$ ; partial  $\eta^2 = .08$ ). **Discussion** The lack of measurable improvement over the intervention period may be due to (1) the extended study duration of 12 months [3]; (2) the lack of social interaction with other participants and the infrequent contact with study personnel [4]; (3) the possible insensitivity of the SF-36 in MS patients [3]; (4) the overall low scores in the ADS-L of the patients included may have masked possible effects on DS [5]. For further studies assessing the impact of endurance training on QoL and DS in MS patients, the aforementioned methodological shortcomings have to be addressed. **References** 1. Miller A & Dishon S. Health-related Quality of Life in Multiple Sclerosis: The Impact of Disability, Gender and Employment Status. *Qual Life Res* 2006; 15: 259–71 2. Lobentanz IS et al. Factors influencing quality of life in multiple sclerosis patients: disability, depressive mood, fatigue and sleep quality. *Acta Neurol Scand* 2004; 110: 6–13 3. Motl RW & Gosney JL. Effect of exercise training on quality of life in multiple sclerosis: a meta-analysis. *Mult Scler* 2008; 14: 129–35 4. Romberg A et al. Long-term exercise improves functional impairment but not quality of life in multiple sclerosis. *J Neurol* 2005; 252: 839–45 5. Sabapathy NM et al. Comparing endurance- and resistance-exercise training in people with multiple sclerosis: a randomized pilot study. *Clin Rehabil* 2010; 25: 14–24

### ASSOCIATION OF PHYSICAL ACTIVITIES AND SEDENTARY BEHAVIORS WITH SLEEP DISTURBANCE BY DIFFERENCE BETWEEN COMMUNITY-DWELLING ELDERLY WITH AND WITHOUT MUSCULOSKELETAL PAIN.

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**[Purpose]** Each factor of physical inactivity and pain is associated with sleep disturbance. However, it is not clear whether association of physical inactivity with sleep disturbance is affected by musculoskeletal pain (MSP). This study examined whether some combinations of physical activities (PA) and sedentary behaviors (SB) led to different association with sleep disturbance between person with and without MSP. **[Methods]** Cross-sectional data were collected on 715 elders aged 65 years and over living in Dazaifu, Japan. MSP was defined as pain that sustains more than 1-3 months during the past year and participants were asked to identify pain locations on a body diagram. Sleep disturbance was analyzed by using the Pittsburgh Sleep Quality Index of the Japanese version (PSQI-J). PA and SB were objectively measured using a triaxial accelerometer (Omron Healthcare, Active Style Pro HJA 350IT). Participants were categorized into four groups (2 groups of PA x 2 groups of SB) according to their levels of PA and SB (divided into 2 levels; low and high levels around the median) under MSP and non-MSP groups. Logistic regression analysis was used to examine effect of PA/SB on sleep disturbance under MSP and non-MSP groups. In the analyses, gender, age, body mass index, smoking, educational attainment were treated as potential confounders. **[Results]** The prevalence of MSP was 60.7%. In those with MSP, significantly higher risks of sleep disturbance were showed in high PA/high SB group (odds ratios [OR] 2.76, 95% confidence interval [CI] 1.37-5.53), low PA/low SB group (OR 2.54, 95% CI 1.35-4.78), and low PA/high SB group (OR 2.36, 95% CI 1.28-4.37), compared with that of the reference group (high PA/low SB group). However, each group without MSP was not significantly associated with sleep disturbance. **[Conclusion]** The combination of low PA and high SB might be the risk of sleep disturbance in older adults with MSP. The result of this cross-sectional study indicates that reduction of SB will be as important as progression of PA in older adults with MSP in particular.

### INFLUENCE OF BLINDNESS ON INTERMITTENT RUNNING PERFORMANCE

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**Introduction** Preliminary data from blind young people reveal a markedly lower aerobic fitness, primarily due to a reduced level of habitual physical activity (Hopkins et al., 1987; Shindo et al., 1987; Aslan et al., 2012). The regular engagement in adapted ball games seems useful in this context (Karakaya et al., 2009). However, data on aerobic fitness and performance of blind adults engaged in adapted ball games is not available. Therefore, the aim of this study was to investigate the influence of blindness on intermittent running performance (IRP) by comparing blind soccer players with physically active PE students under blinded and sighted conditions. **Methods:** n=8 male blind soccer players (BS: age: 29.0±6.7 y) performed an adapted YoYoIR1-test (Bangsbo et al., 2008) with continuous heart rate measurement (Polar RS800) as well as a single leg stance test (max. 120 s) on a balance board (Togu). Additionally, n=11 male PE students (age: 25.1±1.8 y) performed the same tests under both blinded (PE-bl) and sighted (PE-vis) conditions in randomised order. IRP (in m) and exercise heart rate (HR in bpm, HRmax) as well as balance time (in s) were compared between groups by means of mixed ANOVAs. **Results:** Significant group effects were found for IRP (F=40.2; p<0.001;  $\eta^2=0.75$ ) and balance time (F=518.4, p<0.001,  $\eta^2=0.98$ ) with significant lower values in BS (365±165 m; 4±1 s) compared to PE-bl (1069±261 m; 15±15 s) and PE-vis (1378±276 m; 120±0 s), respectively. A significant interac-

tion effect (group x running speed;  $F=19.7$ ;  $p<0.001$ ;  $\eta^2=0.59$ ) was detected for exercise heart rates. While all groups had similar HRmax (BS:  $192\pm 11$  bpm; PE-bl:  $192\pm 7$  bpm; PE-vis:  $193\pm 7$  bpm), PE-bl and BS both exhibited significantly higher HRs at low running speeds compared to PE-vis. Discussion: Similar to a previously reported general reduction in aerobic fitness (Shindo et al., 1987) blind soccer players show a highly reduced (-74%) IRP. Additionally, our data indicate that IRP is directly influenced by the loss of visual control, although to a much lower extent (-22%). Consequently, our results support the notion that blind people should be strongly encouraged to increase habitual physical activity (Hopkins et al., 1987; Shindo et al., 1987; Aslan et al., 2012) in order to reduce the large deterioration in physical fitness and corresponding health prognosis. References: Aslan UB, Calik BB, Kitiş A (2012). *Res Dev Disabil*, 33(6), 1799-804. Bangsbo J, Iain FM, Krusturup P. (2008). *Sports Med*, 38(1), 37-51. Hopkins WG, Gaeta H, Thomas AC, Hill PM (1987). *Eur J Appl Physiol Occup Physiol*, 56(1), 69-73. Karakaya IC, Aki E, Ergun N (2009). *Percept Mot Skills*, 108(1), 129-36. Shindo M, Kumagai S, Tanaka H (1987). *Eur J Appl Physiol Occup Physiol*, 56(5), 501-7. Contact: olaf.hoos@uni-wuerzburg.de

### **INFLUENCE OF HIPPOThERAPY ON RESPIRATORY MUSCLE STRENGTH IN INDIVIDUALS WITH DOWN SYNDROME IN THE FEDERAL DISTRICT, BRAZIL**

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Introduction: Down syndrome, from all genetic syndromes are the most common. Individuals who may have decreased respiratory muscle strength mainly due to hypotonia, a common characteristic in this population. Objective: To analyze the effects of a hippotherapy program on the respiratory muscle strength in individuals with DS practitioners (GE) and non-practitioners (GC) in both genders. Material and methods: The study included 41 subjects with 20 in the experimental group (EG) and 21 of the Control Group (CG), of both sexes, aged 7-13 years, all diagnosed with Down Syndrome (DS). Was used to measure the Manovacuometry respiratory muscle strength, following the protocol proposed by Black and Hyatt (1969), where participants were instructed to perform expiratory maneuvers maximum (MEP) and inspirations maximum (MIP). Statistical analysis was given from a distribution specification. We used the Kolmogorov-Smirnov test to assess the normality of the data distribution and the Levene test to verify homoscedasticity of variables assessing equality or not of variances between groups of variables. Accordingly, after these checks, we used the Mann-Whitney test to determine differences between the means of groups (CG and EG) as using the Spearman correlation test to visualize possible relationships with age and practice time hippotherapy. Adopted a significance level of  $p < 0.05$ . Results: The individuals who performed the practice of hippotherapy showed improvements compared to both inspiratory respiratory muscle strength (MIP) when expiratory (MEP), although no significant difference. Conclusion: This study demonstrates that the hippotherapy program has benefits in respiratory muscle strength in individuals with DS and particularly younger did better. Reference: Costa, V.S.F. Influence of hippotherapy on respiratory muscle strength in individuals with Down Syndrome in the Federal District, Brazil. Master's thesis. University of Brazilia, UnB.

### **INFLUENCE ON V-WAVE RECOVERY CURVE DURING SKIN COOLING USING A DOUBLE STIMULATION METHOD**

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Introduction We have demonstrated the effects of skin cooling on the spinal cord by analyzing the H-reflex recovery curve using a double stimulation method. There was a difference in the time it took to attain peak recovery between CS and NCS (CS:250ms, NCS:300ms). These results suggest that the decrease in H2/H1 with skin cooling is related to elevated motoneuron inhibition. However, there is a possibility that input from cold receptors has an influence on central command. The evoked V-wave response could be used to reflect the magnitude of efferent  $\alpha$ -motoneuron output during voluntary muscle activation. Therefore, the purpose of this study was to investigate the effects on V-wave using a double stimulation with skin cooling. Methods Eight healthy adults volunteered for this study. Isometric contraction force and twitch of the triceps surae were measured with a force transducer attached to a footplate apparatus. Electrical signals were picked up by surface electrodes (10mm) on the belly of SOL and MG. This experiment was performed under two conditions that consisted of skin cooling (skin temp. 26 deg.; SC) and control (skin temp. about 33 deg.; NSC). A cooling pad, attached to the skin, was used in the cooling condition. H-reflexes and M-waves were evoked in the SOL and MG muscles by electrical stimulation of the posterior tibial nerve via a cathode ball electrode (5mm in diameter) pressed into the popliteal fossa. V-waves evoked with a double stimulation (conditioning V-wave: V1, test V-wave: V2) were obtained under the two conditions during 30%MVC. Time intervals between conditioning and test stimulation ranged between 10 and 800ms ( $n=2$ ) and 100 and 300ms ( $n=6$ ). The data analyzed was V-wave peak-to-peak amplitude (V2/V1). Results and Discussion There was no significant difference in Hmax, Mmax and H/M ratio between CS and NCS. There was no significant difference between the amplitude of the control V-wave and V1. Regarding the rate of V2/V1, there was an initial complete depression within several tens of milliseconds and an early recovery attaining a peak at about 150ms under both conditions. The two peaks of recovery at around 100-300 ms has been used as an optimal point for measuring central command excitability in the double V-wave test. However, there was no difference in the time it took to attain a peak recovery between CS and NCS (first peak: 150ms, second peak: 250ms) in SOL and MG. Furthermore, there was no difference in the rate of V2/V1 between CS and NCS. These results suggest that the level of MVC was low therefore high threshold motor units were not recruited at 30%MVC.

### **LIFE QUALITY OF SPINAL CORD INJURED**

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Introduction The spinal cord injury is one of the most disabling syndromes that affect not only young adults with significant social and financial repercussions. People with have partial or total loss of motor, sensitive, autonomous function and complications in their organic system (Maynard et al., 1997). The outcomes of this trauma interfere in the quality of life and the functional capacity of these people, characterizing a dependence on other people's care and limitations that will go on for the rest of their lives (Caffer et al., 2005). Therefore, the aim of this study was to check the level of quality of life in men with spinal cord injury that practice or not physical activity in institutions of the Federal District-Brazil. Methods Data was collected from 30 men with of traumatic etiology, divided in active ( $N=16$ ) and sedentary ( $N=14$ ), ranging from 20 a 60 years old. To collect data, instruments like the SF-36 (medical Outcomes study 36-Item short-Form Health Survey) (Ciconelli et al., 1999) and the survey for the diagnosis of the level of physical activity of the aim population (Matsudo et al., 2000) were used. To the data analyses the frequency, charts, central tendency measurements (average) of dispersion (standard deviation) were

realized. For the tests, levels of significance of 5% were used. Results The age range was 41-50 years old (36,6%) and the average time of injury was 20-30 years (36,6%); As the cause of the injury, the prevalence is fire guns (40%), in its vast majority of injury are total (73,3%) with the predominance of the thoracic level of injury (76,6%). Discussion In relation to the survey the mean domain scores of the SF-36 of spinal cord injuries are presented low values, however, the dominance of functional capacity of the SF-36 of the medullar disabled people that practice physical activities is significantly higher than in relation to sedentary ones. The quality of life is closely related to the lifestyle of the person with cord injury, thus, interventions like physical activity can promote the improvement of the functional independency and quality of life. References Maynard, F.M. et al. International Standards for Neurological and Functional Classification of Spinal Cord Injury. *Spinal Cord*, 35, 266 ± 274, 1997. Cafer, C.L. et al. Nursing diagnosis and proposed interventions for patients with spinal cord injury. *Acta Paulista Nursing*, V.18, nº4. p 347-53, 2005. Ciconelli, R. et al. Translation to Portuguese and validation of the generic assessment of quality of life SF-36 (Brazil SF-36). *Brazilian Journal of Rheumatology*, V. 39, p 144-150, 1999. Matsudo, S.M., Matsudo, V.K.R., Barros, N. TL. Impact of aging on anthropometric, metabolic and neuromotor fitness. *Rev. Bras Cienc e Mov*, 8:21-32., 2000.

### **METABOLIC CHANGES IN HUMAN MUSCLE WITH 90 DAY BED-REST AND RESISTANCE EXERCISE**

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Introduction Spaceflight is a unique environment that poses several physiological challenges to the human body. 90 days of immobility was a good approximation to experience muscle degeneration that occurs with such a long-term immobility (1). Exercise performance during this period was a good test to counteract those effects. The aim of the study was to observe how the glucose metabolism was modified during this period. The assay was performed on muscle biopsies to measure activities of the enzymes controlling glucose metabolism and changes in the expression of corresponding mRNAs before and after starting the experiment. Methods 21 participants performed 90 days of bed rest. They were divided into two groups: group 1. (BR) 12 participants rested, group 2. (BRE) 9 participants exercised. The BRE group trained a concentric-eccentric resistance protocol. Muscle biopsies were obtained from the Vastus Lateralis before and after finish the experience. Glycogen synthase (GS), glycogen phosphorylase (GPh), hexokinase (HK), phosphofructokinase (PFK-1), citrate synthase (CS) activities and their corresponding mRNAs were assessed. Results BR causes a decrease in GS, GPh, HK and CS activities. This decrease is also accompanied by a decrease of mRNAs being significant in their single HK mRNA and CS mRNA. In hiring BR slightly increases the PFK-1 activity accompanied by an important but not significant increase of its mRNA. Exercise training increases the activities of all enzymes being particularly significant the GPh and HK. These increases in activity also correspond to increases in expression of the mRNAs. Discussion In summary, the decrease in energy metabolic capacity provided by the oxidation of glucose that occurs during muscle degeneration caused by prolonged immobility corresponds to a decreased activity of regulation key enzymes that it is controlled by expression of the synthesis of the enzymes involved. These results would be related with the decrease in slow-twitch fibres and an increase of hybrid fibres showed by Trappe et al (2). Exercise training counteracts these losses, increasing the new synthesis of mRNA and so does the protein expression of these enzymes. References 1. Edgerton VR, Roy RR. 1995: NASA 2003. The gravitational environment. Oxford University Press, NY, 721-763 2. Trappe S et al. *J Physiol* 2004 : 557,2 , 501-513 Funded by European Space Agency (ESA 12RL000214)

### **DO CANCER PATIENTS RE-CALL PHYSICAL ACTIVITY FROM LAST WEEK?**

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Background: Feasible, valid and reliable measures are important when quantifying physical activity (PA) level in cancer patients. The short form of the International Physical Activity Questionnaire (IPAQ-sf) is a validated and commonly used questionnaire to assess PA in adults. However, the IPAQ-sf has not previously been validated in cancer patients undergoing oncologic treatment. Objective: The objective of the present study was to compare IPAQ-sf with objective measures of physical activity in cancer patients receiving chemotherapy with curative or palliative intent. Materials & Methods: The present study was part of a 12-month prospective individualized lifestyle intervention focusing on diet, PA, stress management and smoking cessation in 100 cancer patients undergoing chemotherapy with curative or palliative intent. During the first 2 months of the lifestyle intervention, participants were instructed to wear a SenseWear™ Armband (SWA) for 5 consecutive days before completing the IPAQ-sf at the cancer center while receiving chemotherapy. From SWA, PA of moderate- or vigorous intensity (MVPA) >10 min duration were compared with self-reported values from the IPAQ-sf. Walking was included in MVPA from the IPAQ-sf. Results: 66 patients both completed IPAQ-sf and wore the SWA over 5 days. MVPA was 844 and 181 min/week with the IPAQ-sf and SWA, respectively. IPAQ-sf significantly overestimated MVPA by 663 min/week, or 366% compared to SWA (p=0.001). Comparing MVPA, IPAQ-sf and SWA, the mean difference and limits of agreements from the Bland-Altman plots were 662 (±1707) min/week. Discussion: Using the IPAQ-sf, cancer patients participating in an individualized comprehensive lifestyle intervention while undergoing curative or palliative chemotherapy overestimated MVPA by almost 100 min/day. The size of overestimation made over 7 days is larger than the American Cancer Society's PA guidelines for cancer patients of minimum 150 min/week of moderate PA. Conclusion: Based on the present finding of a large overestimation of PA, the IPAQ-sf cannot be recommended as an assessment tool addressing PA level for cancer patients undergoing oncologic treatment.

### **COMPARISON OF PHYSICAL ACTIVITY BETWEEN ADOLESCENTS LIVING IN A COASTAL AREA AFFECTED BY THE GREAT EAST JAPAN EARTHQUAKE AND TSUNAMI AND THOSE OUTSIDE AN AFFECTED AREA**

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Introduction The 2011 Great East Japan Earthquake and Tsunami had a significant effect on the lifestyle of Japanese adolescents; in particular, the physical activity of victims from the submerged coastal areas seems to have been considerably deteriorated. This study aimed to compare the physical activity between middle school students living in an affected coastal area and those living outside an affected area. Methods A total of 418 middle school students in seventh and ninth grades from an affected coastal area (N = 222) and outside an affected area (N = 196) were enrolled at 2 years after the earthquake. Students were asked to report their personal and demographic characteristics and their activities by using World Health Organization's Health Behaviour in Schoolchildren (HBSC) questionnaire (Booth et al., 2001) and time spent sitting during weekdays and weekends. In addition, the number of daily steps was assessed using an accelerometer. Results Independent t-test (t = -2.2, df = 297, p < 0.05) revealed that students living outside an affected area

(530 ± 263 min/day) spent significantly more time sitting per day during weekdays than did those living in the damaged coastal area (461 ± 293 min/day). In contrast, the number of daily steps (in affected coastal area 7,020 ± 2,687 vs outside the area 7,304 ± 2,371 steps/day) and activity as per HBSC questionnaire (in affected coastal area 64% vs outside the area 68% active) were not significantly different. Discussion Our study results indicated that the daily steps of students in both areas were lower than those of previous studies (Tudor-Locke et al., 2011; Adams et al., 2013); however, the daily steps did not significantly differ among the two student groups. Moreover, time spent sitting during weekdays among the students living in the damaged area was lower than those of living outside the damaged area. It seemed that school-based interventions taken by the teacher reduces the time spent sitting during weekdays. Specifically, club activities after class in the school may be important for improvement of their activities. Further studies are needed to examine their personal and demographic characteristics longitudinally. References Booth ML, Okely AD, Chey T, Bauman A. (2001) *Br J Sports Med*, 35, 263-267. Tudor-Locke C, Craig CL, Beets MW, Belton S, Cardon GM, Duncan S, Hatano Y, Lubans DR, Olds TS, Raustorp A, Rowe D, Spence JC, Tanaka S, Blair SN. (2011) *Int J Behav Nutr Phys Act*, 8, 78. Adams MA, Johnson WD, Tudor-Locke C. (2013) *Int J Behav Nutr Phys Act*, 10, 49. Contact Correspondence to: Kanzo OKAZAKI <kanzook1015@hotmail.com >

## PHYSICAL ACTIVITY AND OBESITY IN DOWN'S SYNDROME

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Introduction Down syndrome is known to be a chromosomal condition that is associated with intellectual disability, a characteristic facial appearance, and weak muscle tone in infancy. Children with Down syndrome have a higher risk for developing obesity. Because of the negative consequences associated with obesity, prevention and interventions in children with Down syndrome should be a major health priority. In our study, to find out the prevalence of overweight and obesity in Down's syndrome, 578 french children and adults living in communities were studied. Body Mass Index (BMI) and its relationship with environmental factors as dietary habits and physical activity were studied. Methods We analyzed 239 women (27.5 ± 14.5 years-old) and 339 men (29.2 ± 13.7 years-old) located in 3 social medical centers in France. A questionnaire was used via the National file of the sanitary and social establishments (FINESS) and anthropometric measures (weight, height and BMI calculated), demographic data (age) and different indicators: diet program, physical activity (endurance, continuous exercise) were determined. Results It was found that 45.4% of males and 61% females were categorized as overweight and obese. The middle BMI in our population was 25.4 kg/m<sup>2</sup> but the prevalence of obesity and overweight is 52,4% in contrast to the one of the French population which is 39%. 1,9 % of subjects are thin and 6,2 % are in severely or massively obese. The middle BMI increases from 41-50 years and decreases after 60 years. Overweight and obesity affect 61 % of the women against 44,5 % of the men. We observed that physical activity is associated with a lower category of BMI about 4 kg/m<sup>2</sup>. The age, the interaction of sex and diet and physical activity are significant according to the BMI category. Even if the cause of obesity in people with Down syndrome is unknown and probably multifactorial, it would include the food habits, depressed metabolic rate, reduced exercise and endocrine abnormalities (Bricout, 2007; Fernhall, 2009; Mendonca, 2013). Discussion-Conclusion Physical activity alone is associated to a decline of BMI (p < .05) while, interaction of dietary and physical activity has no influence in the decline of BMI. References Bricout V. A., Flore P., Guinot M., Faure P., Garnier P., Eberhard Y., Juvin A. F. *Science & Sports*, 2007 (22) :293-296. Fernhall Bo., Baynard T., Collier Scott R., Figueroa A., Goulopoulou S., Kamimori Gary H., Piteffi Kenneth H. *The American Journal of Cardiology*, 2009 (103) :724-726. Mendonca Goncalo V., Pereira Fernando D., Fernhall Bo. *Research in Developmental Disabilities*, 2013 (34) : 353-361. Contact sandra.joffroy@univ-ils3.fr

## Biomechanics

### EFFECTS OF TENNIS ON PARASPINAL MUSCLES IN PREPUBESCENT AND PROFESSIONAL PLAYERS: A VOLUMETRIC MRI STUDY

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Introduction. Tennis practice imposes a great stress in the lumbar spine musculature [1]. In children and professional tennis players, the upper extremity muscles are hypertrophied asymmetrically [2, 3]. The purpose of the present study was to assess if tennis induce the asymmetric hypertrophy of paraspinal (PSP) muscles in prepubescent (PRE) and professional (PRO) tennis players. Methods. Magnetic resonance imaging (MRI) was used to determine the volume of PSP in 8 male PRO (21.9 years), 7 male PRE (11.0 years, Tanner 1-2) and 16 male non-active controls (10 prepubescents: 11.0 years, Tanner 1-2; and 6 adults: 23.5 years). The MRI images (L1-L2 intervertebral disc to pubic symphysis), were used to calculate the volume of PSP (iliocostalis lumborum, multifidus, longissimus thoracis, spinalis thoracis analyzed conjointly). Differences between sides were assessed using Student's paired t-tests. Significant differences were assumed when P<0.05. Results PSP had similar volumes in the non-dominant and dominant sides in PRE (214.8±49.1 vs 215.7±45.7 cm<sup>3</sup>, respectively, P=0.93), PRO (495.7±97.5 vs 476.5±108.3 cm<sup>3</sup>, respectively, P=0.12) and control subjects, children (194.0±41.8 vs 186.9±37.6 cm<sup>3</sup>, respectively, P=0.08) and adults (458.1±77.9 vs 442.0±69.5 cm<sup>3</sup>, respectively, P=0.20) Discussion The present study shows that tennis induces a symmetric development of PSP muscles at prepubertal age. Also, that side-to-side symmetry in the muscle volume of PSP remains at a professional level. In addition, our results show that daily living activities during childhood and adulthood also induce a symmetric degree of hypertrophy of PSP muscles. Conclusion The muscle volume of paraspinal muscles (analyzed conjointly) is similar in the dominant and non-dominant sides, in tennis players and in physically non-active population, children and adults. Acknowledgement ULPGC2013-24 References 1. Gallotta, M.C., et al., Acute effects of two different tennis sessions on dorsal and lumbar spine of adult players. *J Sports Sci*, 2014: p. 1-9. 2. Sanchis-Moysi, J., et al., Muscle hypertrophy in prepubescent tennis players: a segmentation MRI study. *PLoS One*, 2012. 7(3): p. e33622. 3. Sanchis-Moysi, J., et al., The upper extremity of the professional tennis player: muscle volumes, fiber-type distribution and muscle strength. *Scand J Med Sci Sports*, 2010. 20(3): p. 524-34.

## THE CHARACTERISTICS OF LOWER LIMB MOTOR FUNCTION AND KINEMATICS OBSERVED IN 2 STEP TEST: FOCUS ON THE DISTINCTION AMONG THE RISK OF FALLING.

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Introduction 2 step test (2ST) is known to measure the walking ability. This calculates the 2 step value (2SV), which standardize the maximum distance of 2 strides divided by their height (Muranaga, 2003). Moreover, This 2ST can conveniently evaluate the walking ability unlike other methods measuring it. However, it has not validated the characteristics of lower limb kinematics in 2ST. The purpose of this study is to reveal the characteristics of lower limb kinematics dependent on the risk of falling from the 2SV. This can be useful to prevent the falling. Method Subjects were 18 elderly (Age:  $74.7 \pm 3.3$  years old). 2ST was performed twice bilaterally and analyzed the reflective markers applied on body landmarks by using Vicon MX. The 2SV is divided into 3 groups (Poor: P which is above 1.25, Normal: N which is 1.26-1.50, and Good: G which is above 1.51). In this study, the analysis of lower limb kinematics was only on the initial side and categorized 3 stages; the 1st stage is from the start to the initial foot contact, the 2nd stage is from the initial foot contact to the second foot contact, and the 3rd stage is from the second foot contact to the finish, which gathers the both feet. In addition, lower limb ROM and both isometric and isokinetic muscle strength of the knee were also evaluated. One Way ANOVA ( $P < 0.05$ ) was used for the statistical processing and Benferroni Method was used for a multiple comparison. Result The statistically significant was shown next. In G, the knee flexion angle at the mid phase of the 2nd stage, the ankle plantar flexion angle, and hip extension angle at the initial phase of the 3rd stage were statistically significant compared with P. Furthermore, isometric knee extension strength, as well as knee flexion strength, were statistically significant at angler velocity  $0^\circ$  and  $60^\circ$ . Regarding lower limb range of motion, both hip extension and flexion were also statistically significant in G compared with P. Conclusion This study showed that G possesses the strides by flexing knee deeply first followed by extension. It is assumed that greater muscle strength is necessary to manage the deep knee flexion and propel the lower limb farther in this stage and the results of isometric knee strength supported this finding. Furthermore, the knee joint movement at the mid phase of the 2nd stage will affect the angler difference in hip and ankle at the initial phase of the 3rd stage. For the lower limb ROM, the hip extension ROM after the initial knee flexion phase could be the key component. This suggested that the knee movement at the mid phase of the 2nd stage greatly influences the difference in 2SV.

## MUSCLE ACTIVATION OF WORLD-CLASS BREASTSTROKE SWIMMERS

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Introduction Quantification of muscle activity can provide coaches and athletes with a better understanding of coordination, co-activation, muscle intensity and the relative muscle contribution to the overall propulsion in complex dynamic movements such as breaststroke (BR) swimming. It is also important in order to understand movement economy at the muscular level with increasing intensity. Therefore, the aim of this study was to investigate muscle activity with surface electromyography (EMG) in world-class (WC) BR swimmers performing at 60% and 100% of maximal effort. Methods Four WC BR swimmers (FINA points  $998 \pm 19$ ) with medalist at Olympic Games, World- or European-championship within the past two years participated; two females (age  $25.5 \pm 4$  yrs; height  $167 \pm 1.4$  cm; weight  $66.2 \pm 10.1$  kg) and two males ( $27.3 \pm 1.7$  yrs;  $188 \pm 2.8$  cm; weight  $86.6 \pm 0.8$  kg). They performed 25 m of BR at 60% and 100% of maximal effort. The muscle activity was recorded using waterproof electrodes and active sensors and recorded according to Olstad et al. (2014a) during 5-10 stroke cycles in triceps brachii (TB), biceps brachii (BB), trapezius (pars descendens) (TR), pectoralis major (pars clavicularis) (PM), gastrocnemius med. (GM), tibialis anterior (TA), biceps femoris (BF) and rectus femoris (RF) at 1000 Hz. Each stroke cycle was divided into three phases based on the leg kick; propulsion (PP), glide (GP) and recovery (RP). Paired t-tests were used for peak amplitude EMG, integrated EMG (iEMG) and average EMG per cycle/phase. Results The swimmers showed high reproducibility in terms of EMG peak value and time between two consecutive EMG peaks. At 60% intensity peak EMG amplitude was found during the PP for GM, TA, BF and RF, in GP for TB, and in RP for BB, TR and PM. At 100% the peak EMG amplitude changed for BB, TR and PM to the GP. The amplitude peak as well as iEMG was significantly higher for all muscles at 100% compared to 60% ( $p < 0.01$ ). Average EMG per phase showed the lowest activity during the GP for TR, GM, TA, BF and RF at 60% and 100%, except for GM showing least activity during the RP at 100%. The same muscles showed the highest activity during the PP. TB, BB and PM had the lowest activity during the PP at both 60% and 100%, and the highest activity during the GP. Discussion World-class BR swimmers show a very consistent EMG pattern across multiple stroke cycles and different velocities. The change in peak EMG amplitude for the upper body at 100% towards the GP of the legs can be used to reduce the intra-cyclic velocity variations in the stroke. Low EMG activity of the leg muscles during GP indicates an economical use of the muscles with relaxation during the GP as well as upper body at the PP. An increase for GM in GP at 100% can indicate a more active use to create a better streamline position of the feet. References Olstad BH, Zinner C, Cabri J, Kjendlie PL (2014a). J Electromyogr Kines, 24, 698-703. Contact b.h.olstad@nih.no

## MUSCLE ACTIVATION AND KINEMATIC DIFFERENCES BETWEEN FEMALE AND MALE ELITE BREASTSTROKE SWIMMERS

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Introduction Studies on muscle activation in swimmers are almost exclusively performed irrespective of sexes. In breaststroke (BR), potential differences in muscle activation between sexes are unknown. The aim of this study was to investigate muscle activity during the stroke cycle and different phases in BR at three levels of intensity (60, 80 and 100% of maximal effort) in female and male elite swimmers. Methods Nine elite breaststrokers (FINA points  $844 \pm 150$ ) participated; five females (age  $20.3 \pm 5.4$  yrs; height  $168.5 \pm 3.7$  cm; weight  $64.3 \pm 5.4$  kg) and four males ( $27.7 \pm 7.1$  yrs;  $186.5 \pm 2.9$  cm; weight  $84.8 \pm 2.2$  kg). The swimmers performed 25 m of BR at 60, 80 and 100% of maximal effort. Muscle activity was recorded using waterproof electromyography (EMG) electrodes and active sensors according to Olstad et al. (2014a) during 3-5 stroke cycles in triceps brachii (TB), biceps brachii (BB), trapezius (TR), pectoralis major (PM), gastrocnemius medialis (GM), tibialis anterior (TA), biceps femoris (BF) and rectus femoris (RF) at 1000 Hz. Each stroke cycle was divided into three phases based on the leg kick; propulsion (PP), glide (GP) and recovery (RP). Kinematics was recorded using 3D automatic motion tracking (Olstad et al., 2014b). Independent samples t-tests were used to compare integrated EMG (iEMG), cycle/phase and stroke length, stroke rate, velocity and knee angles during the different phases and the full stroke cycle. Results In a total of 96 iEMG measurements, significant differences ( $p < 0.05$ ) were only found for RP GM 100% and GP BF 80% where females had higher values than males, and for total iEMG in TA at 60%, RP TA 60% and 80%, and PP BB 80% where males had higher values. Of 51 kinematic measurements, differences were found in cycle

length at 60%, knee angle during GP for all effort levels (females higher), velocity during GP and time in PP at 100%. At 60-80-100% effort males had higher velocity in all three phases compared to females. Males had longer stroke lengths, but females had longer PP. Female swimmers spent more time in PP and RP while males had a longer GP at 60% effort. At 80 and 100% males decreased their GP time significantly more than females. At 60% effort females had higher stroke rate, but not at 80 and 100%. Males had significant larger knee angles in PP and RP, but not in GP. Discussion Significant differences in velocity and stroke-length were demonstrated between female and male BR swimmers. However, only few significant differences were found in muscle activity during the stroke cycle and the phases in BR. This indicates that factors other than muscle activation, contribution and interplay during the stroke cycles explain the sex differences in performance of elite breaststrokes. References Olstad BH, Zinner C, Cabri J, Kjendlie PL (2014a). *J Electromyogr Kines*, 24, 698-703. Olstad BH, Zinner C, Haakonsen D, Cabri J, Kjendlie PL (2014b). *Biomechanics and medicine in swimming XII*, 195-199.

### DEPENDENCE OF SPORTS RESULT IN JERK OF THE BAR FROM THE LEVEL OF PHYSICAL READINESS OF SPORTSMEN AND BIOMECHANICAL PARAMETERS OF MOVEMENT

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Introduction The sports result in weight lifting is substantially determined by a level of technical skill and physical readiness. Revealing of the most significant and informative parameters of technical and special physical readiness of sportsmen allows to obtain the objective data for development of more effective models of preparation and improvement of quality of work the account of correction of an orientation, structure and the contents of training employment, and also selection of more effective means of technical and physical preparation at various stages of becoming of sports skill. The purpose of research – definition of biomechanical parameters of technical equipment of jerk of a bar and parameters of special physical readiness, revealing of features of interrelation, and also studying of joint influence of parameters of readiness on result in jerk. Methods For achievement of an object in view research in which weight-lifters of various qualification in the age of 20-23 years (n=10) have taken part is carried out. Biomechanical parameters of technical equipment of jerk of a bar were determined with the help of the complex tool technique. The standard methods of mathematical statistics were applied to the analysis of results of research. Results The result in jerk has a high degree of interrelation with a parameter of the maximal force of muscles of the bottom extremities to what high factors of correlation between results in knee-bend and competitive results in jerk ( $r=0.85$ ) testify. The analysis of interrelation of result in jerk and in jumping tests testifies that the greatest sizes of factors of correlation have parameters in such tests as a jump upwards without burdening with fast switching in work of muscles of the bottom extremities from a conceding mode on overcoming ( $r=0.80$ ). This test allows to estimate a level of explosive force in a combination to ability of the sportsman effectively to use in movements of a similar sort energy of elastic deformation of the muscles-copular device. Discussion / Conclusion The analysis of results of research testifies to presence of close and significant interrelation of results in jerk and test exercises with dynamic characteristics of movement which are connected to performance of draft and undermining. So, value of the maximal effort on which efficiency of performance of undermining and as a whole productivity in jerk ( $r=0.86$ ) depends, has high positive connection as with the explosive force determined in jumping test ( $r=0.76$ ), and with the maximal any force determined in knee-bends with a bar of limiting weight ( $r=0.82$ ).

### COMPARISON OF CONCENTRIC FORCES BETWEEN TWO VERTICAL JUMPS ON LAND OR IN WATER

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Introduction Water is an ideal environment for carrying out jumps, reducing impact force through buoyancy, but it could also provides a floating interface may affecting the force production during takeoff when bounce followed by dynamic squatting. Therefore, the purpose of this study was to investigate the peak ground reaction forces (GRF) during takeoff of squat jump (SJ) or countermovement jump (CMJ) between on land or in pool of water. Methods 14 male minor-league college volleyball players were recruited in this study (average height was  $175.68 \pm 3.90$  cm, the average body weight (BW) on land was  $64.14 \pm 4.72$  kg, and the aquatic BW was  $36.30 \pm 3.20$  kg). Before conducting the experiment, they were all measured the length from malleolus lateralis to trochanter major of the dominate leg for the water level in the swimming pool by an adjustable underwater platform. Then participates were asked to perform two jumps on land or in water randomly on an AMTI water-proof force measurement device. We recorded three successful SJ and CMJ in land and aquatic based condition and analyzed the peak GRF during takeoff of each jump. The force data were normalized by the BW in the condition. Furthermore, the condition-difference was calculated by water value divided by land. Repeated measures two-way ANOVA (analysis of variance) method was used to exam peak GRF of two jumps in two conditions and a pair t test was carried out for the ratio of jump forces between land and water conditions. Results The results were showed no significant interaction between jumps and conditions. The peak GRFs of SJ are  $3.16 \pm 0.37$  BW on land and  $4.93 \pm 0.83$  BW in water as well as those of CMJ are respectively  $2.51 \pm 0.28$  BW and  $3.93 \pm 0.51$  BW. The SJ forces are significantly higher than CMJ in both conditions. However, the GRF ratio of different conditions were no difference between SJ and CMJ ( $1.57 \pm 0.26$  vs  $1.59 \pm 0.31$ ). Discussion Although the BW in water is approximate 56.63% on land because of the buoyancy, the aquatic GRFs during takeoff are higher of SJ and CMJ by 1.56 and 1.57 times respectively. The concentric GRF usually refers exercise intensity. Therefore, that means jumping in water needs more force production to overcome water drag resistance than the gravity on land. However, the difference between land or water condition among SJ and CMJ are the same. Therefore, this finding suggests that aquatic jump regardless types are an alternative to exercise training on land. References Donoghue OA., Shimojo H, Takagi H. (2011). *Sports Health*, 3(3), 303-309. Ebben WP, Fauth ML, Garceau LR, Petushek EJ. (2011). *J Strength Cond Res*, 25(12), 3288–3298. Colorado JC, Garcia-Masso X, Gonz á lez LM, Triplett NT D, Mayo C, Merce J. (2010). *Int J Sports Med*, 31, 118 – 122. Triplett NT, Colorado JC, Benavent J, Alakhdar Y, Madera J, Gonzalez LM, Tella V. (2009). *Med Sci Sports Exerc*, 41, 1790-1796 Contact: wanchin\_c@utaipai.edu.tw

### DIFFERENT ATTACHMENT POINTS OF RESISTED METHODS AND ITS CONSEQUENCES IN VELOCITY TRAINING: A DYNAMOMETRIC STUDY

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Introduction: The use of special means and methods in order to improve the speed and acceleration has become a common practice in Athletics. However, few studies have analyzed the changes of different resisted means in relation to dynamic parameters and its consequences for competitive performance. The aim of this study is to determine the dynamometric variables from resisted methods when

athletes reach their maximum speed and to check whether the use of different attachment points induce changes in the pattern of the curves of the ground reaction force. Methods: From a force platform, 11 sprinters performed 3 speed exercises, in order to assess the ground reaction forces. Data were analyzed in Matlab and the time of the relevant moments in the force curves, forces magnitude, angles and ground reaction impulses of the support phase of the athletes were determined. Results: The observed results indicated that: (i) the use of resistive exercise time favors the increase in the propulsive phase, decrease in the braking phase and advance of the moment at which the local maximum peak braking and propulsive horizontal (ii) the use of the belt promotes increased propulsive impulses and shows to be the most suitable for the acceleration phase, (iii) the application of the vest promotes increased magnitude of the vertical force active and appears to be the most suitable for middle weathered the phase of maximum speed; (iv) the increase of vertical forces were more relevant to the distinction between elements faster and slower the normal race. Conclusion: In the studied sample, the use of resisted methods induced changes in the patterns of the curves of the ground reaction force. Contact: luis.training75@gmail.com

### MUSCLE ACTIVITIES IN LOWER LIMB AFFECT TO THE CRANK FORCE DURING MAXIMAL PEDALING

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Introduction The anaerobic power generation capacity during maximal pedaling affected by work load and pedaling frequency. It has been reported that muscle activity level was effected to the pedaling frequency. However, the characteristics of crank force due to the muscle activity in maximal pedaling with different work load is not clear. Therefore, the purpose of this study was to investigate the crank force and efficiency of pedaling produced by the muscle activities in lower limb during maximal pedaling. Methods Subjects were 21 collegiate males. The anaerobic power, crank force and angular velocity were measured using a cycling ergometer and a custom-made measurement system. Subjects performed maximal pedaling for 10s with loads of 5%kp (light load) and 10%kp (heavy load) to body weight. In addition, ratio of anaerobic power per crank force (AP/CF ratio) was calculated in all the subjects. Lower limb muscle activities of rectus femoris, vastus medialis, vastus lateralis biceps femoris, tibialis anterior and gastrocnemius were measured by surface electromyography (EMG). Moreover, crank force per integrated EMG ratio (CF/iEMG ratio) as an efficiency of pedaling was calculated for all subjects. Results The crank force was closely related to the anaerobic power in light and heavy loads. The AP/CF ratio on heavy load was significantly higher than that of light load. The muscle activity pattern of the rectus femoris and biceps femoris under both loads were significant difference in up stroke phase. Moreover, under the light load, CF/iEMG ratios of all muscles were significantly lower value due to increased crank angular velocity. On the other hand, no significant difference was observed in the CF/iEMG ratio of the knee extensors muscles. Discussion In this study, the crank force was closely related to the anaerobic power in maximal pedaling with light and heavy loads. A significant difference of muscle activity pattern were observed in hip and knee flexion phase in spite of work load. And also, efficiency of pedaling was differed by work load. From these results, it was suggested that the crank force produced by muscle activity may affected to the pedaling efficiency during maximal pedaling. References Hug F, Dorel S. (2009), J. Electromyogr. Kinesiol., 19, 2, 182-189. Rouffet DM, Hautier CA. (2008), J. Electromyogr. Kinesiol., 18, 5, 866-878. Samozino P, Horvais N, Hintzy F. (2006), Med. Sci. Sports Exerc., 39, 4, 680-687. Sarre G, Lepers R, Maffiuletti N, Millet G, Martin A. (2003), Eur. J. Appl. Physiol., 88, 476-479. Contact st4986@hotmail.com

### STRUCTURAL AND CONTRACTILE PROPERTIES OF THE THIGH MUSCLE IN SPRINTER AND LONG DISTANCE RUNNERS

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Introduction It is well known that structural and functional characteristics of the lower limb muscle was affected by specific training mode. Especially, in muscle fiber properties, sprinter has exceed fast twitch fibers, muscle contraction velocity of sprinter was higher than long distance runners. However, contractile property and size of the belly in thigh muscle were not cleared. Therefore, the purpose of this study was to clarify the muscle structure and contractile properties of the thigh muscle in sprinters and long distance runners. Methods Subjects were 20 sprinters (SP; aged 20.3±1.9yrs, height 171.4±4.8cm and weight 62.8±5.4kg), 14 long distance runners (LDR; aged 19.6±1.0yrs, height 170.7±4.6cm and weight 55.7±3.8kg) and 9 collegiate students of physical education (CON; aged 20.7±1.3yrs, height 176.5±3.7cm and weight 72.6±13.5kg) as control group. Muscle belly in Rectus femoris (RF), Vastus medialis (VM), Vastus lateralis (VL) and Biceps femoris (BF) were measured by ultrasonic scanning method. Contractile response of the muscle belly was recorded by TMG method. The displacement sensor was positions at the surface of the belly in each muscles. Single twitch stimuli with two surface electrodes were used to obtain the dynamic response. Three contractile parameters of delay time (Td), contraction time (Tc) and maximal displacement of the muscle belly (Dm) were analyzed by TMG method. Results Muscle thickness of RF, VM and VL were not significant difference among the groups. Whereas, Thickness of the BF in LDR showed significant lower values than SP and CON groups. In SP, the Td of the muscle belly twitch response of RF (22.9±2.6ms), VM (19.7±1.7ms) and BF (22.1±2.0ms) were significant lower than that of LDR and CON groups. Td of LDR was observed highest values in VL (22.6±1.9ms). Tc value of RF in SP (25.3±4.9ms) was lower than that of LDR (29.4±3.2ms). Also, same tendency was observed in VM (21.8±2.8ms) and BF (27.6±10.4ms). Dm of muscle belly of each muscles were not differed among the groups. Discussion In this study, it is cleared that muscle thickness as a structural characteristics was significant differed between SP and LDR in BF. Whereas, Td and Tc as a contractile properties of muscle belly except for VL in thigh were significant shorter in SP than other groups. From these results, it was considered that contraction parameters using TMG method may evaluate the muscle contractile properties due to athletic training modes. Reference Dahmane R, Djordjevic S, Smerdu V. (2006). Med Bio Eng Comput, 44(11), 999-1006. Valencic V, Knez N. (1997). Artificial Organs, 21(3), 204-242.

### CHANGES IN BILATERAL ASYMMETRY OF PEDALLING POWER AND MUSCLE ACTIVITY DURING 30 SECONDS ISOKINETIC SPRINT CYCLING

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Introduction Notable asymmetry in bilateral biomechanical patterns of the pedalling has been declared by earlier studies. It seems that effort increase, due to higher power output or accumulated fatigue, improves the pedalling symmetry of the crank torque production (Carpes et al., 2010), but there are also opposing findings (Bini and Hume, 2014). It is noted that pedalling kinetics asymmetry may not be related to bilateral differences in the muscle activation magnitude and its variability (Carpes et al., 2011). The purpose of present study

was to compare muscle activity and pedalling power patterns between dominant (DO) and no dominant (ND) leg and examine the changes in asymmetry during fatiguing. Methods The pedalling power (POW) and force production smoothness (PS- mean and peak effective force ratio in %) and EMG of VL, RF and BF of seventeen competitive cyclists were measured bilaterally during maximal 30s isokinetic seated cycling test with the cadence of 100 rpm. Asymmetry index (AI%) between DO and ND side in normalized RMS EMG amplitude, EMG median frequency (MF), POW and PS of first and last 5 second period were computed and statistical significance of differences between DO and ND side and AI% in start and end part of the test were examined. Results The DO side POW and PS values were significantly ( $p < 0.05$ ) higher than ND in start (POW:  $524 \pm 96$  v  $466 \pm 81$ ; PS:  $33.8 \pm 2.9$  v  $30.7 \pm 4.2$ ) and end (POW:  $349 \pm 56$  v  $335 \pm 48$  W; PS:  $32.3 \pm 3.7$  v  $29.8 \pm 4.5\%$ ) of the test. Lateral POW AI was reduced from  $11.4 \pm 13.2$  from start to  $3.9 \pm 5.8\%$  in the end, PS AI did not change. No dominance dependent differences were found in normalized EMG amplitude and MF values in initial part of the test, but at the end of the test was noted significantly lower EMG amplitude in BF of DO leg. No significant changes were found in AI of EMG parameters between start and end part. Discussion The results of present study indicate that asymmetry in pedal force patterns is leg dominance dependent and decrease with fatiguing, this is in line with previous findings (Carpes et al., 2010). At the same time no directional asymmetry and significant systematic change in AI was found in EMG patterns. It supports Carpes et al. (2011) findings that in incremental and constant load tests pedalling force asymmetries in favour of the preferred leg during pedalling are not directly related to the magnitude of muscle activation. References Bini RR, Hume PA. (2014). *Int J Sports Physiol Perform*, 9(5):876-881 Carpes FP, Diefenthaler F, Bini RR, Stefanyshyn DJ, Faria IE, Mota CB. (2011). *J Sports Sci*, 29(2):151-159 Carpes FP, Mota CB, Faria IE. (2010). *Phys Ther Sport*, 11(4): 136-142. Contact rannama@tlu.ee

## THE DIFFERENCING OF STRING TENSION ON HITTING PERFORMANCE IN BANMINTON ATHLETE

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THE DIFFERENCING OF STRING TENSION ON HITTING PERFORMANCE IN BANMINTON ATHLETE Introduction String tension is very important during badminton game because it is a last part of the racquet to be contact a shuttlecock and. The tension will result directly to bouncing and landing target of the shuttlecock. So, appropriate string tension would result in a more effective in badminton game. The purpose of this study was to investigate the effect of string tension on hitting performance in badminton athlete. Methods Three reflective markers was attached on dominant arm of athlete's skin: Shoulder, elbow and Wrist. Marking a reflective tape on shuttlecocks base to determine velocity. Athlete selected a racquets randomly with a different in string tension (22, 26, 30 pounds / ft<sup>2</sup>) that confirmed tension after stringing by using sound frequency analysis. Then, athlete was request to hitting 10 times for each tension by using jump smash skill. The data was recorded via 4 high speed cameras that operating at 500 Hz. Screening 5 times as a perfect hitting to analyze arm angular velocity and shuttlecock velocity when passing a reference position. All Data were digitized and smoothed by using cut of frequency at 200 Hz. A one-way ANOVA (1x3) design with repeated measure was applied to examine the possible interaction between each string tension. Results The results showed that an average arm angular velocity increased when using higher string tension. (average velocity  $742.29 \pm 5.71$ ,  $770.96 \pm 4.58$ ,  $797.97 \pm 7.59$  deg/sec. respectively). However, there was no significant difference in the speed of the shuttlecock at a reference position. Discussion Our study showed a relationship when the tension was changed higher, it will be effect athlete increased their angular velocity respectively to maintain a speed of the shuttlecock. This result is based on the theory and research in practice that has previously said that the less tension will provide faster speeds than the higher tension (Brody, 1979; Brannigan & Adali, 1980; Bower & Cross, 2005;). In competition, this factor may have effect on achievement or make an advantage for athletes. References Brody, H. (1979). *Physics of the tennis racket*. *American Journal of Physics*, 47, 482 – 487. Brannigan, M., & Adali, S. (1980). *Mathematical modeling and simulation of a tennis racket*. *Medicine and Science in Sports and Exercise*, 1, 44 – 53. Bower, R., & Cross, R. (2005). *String tension effects on tennis ball rebound speed and accuracy during playing conditions*, *Journal of Sports Sciences*. Contact Vanasant1@gmail.com, Somjarod@gmail.com, Tel. +662-314-6121

## KNEE INJURY ASSESSMENT USING SUBJECT-SPECIFIC BIOMECHANICAL MODELS OF HUMAN KNEE JOINT

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Introduction: Finite element (FE) models of the knee joint were developed to study the mechanics of soft tissue injury. The main tissues of interest are ligaments and articular cartilage. An ACL tear occurs over 250,000 times annually; costing over \$1 Billion in the U.S (1). Theories surround how these injuries occur, such as motion combinations, unbalanced musculature, etc. Subject specific injury analysis is a novel method to determine the motions to lead to tissue failure in individuals. Subject specific injury mapping has not been performed using FE modeling. The need for individualized injury detection stems from the unique tissue geometries of each patient. This study describes the technique developed to detect individualized injuries. Method: We developed a robust protocol for building subject-specific biomechanical models of the human knee joint. Magnetic resonance imaging, motion analysis and force platform data in conjunction with detailed 3D finite element models were used in the construction of each biomechanical model. The proposed protocol allows estimation of stresses, forces and contact kinetics in different knee elements during various activities. Results: In this investigation the knee undergoes sudden displacements and rotations, as typical in sports. The posterolateral bundle of the ACL demonstrated higher rupture susceptibility than the anteromedial bundle. The average varus angular displacement of ACL failure was 46.6% lower compared to the average valgus angular displacement. Femoral external rotation (ER) decreased the frontal plane angle required for ACL failure by 27.5% compared to femoral internal rotation. Articular cartilage damage was shown to initiate prior to ACL failure during valgus failure. The simulations demonstrating higher ACL injury susceptibility, ER and valgus, showed cartilage damage in these regions. Conclusion: Our study provides new insight into the mechanisms of tear initiation and propagation in knee ligaments and cartilage damage. The results show the ACL most likely to tear in ER, combined with valgus. Our simulations correlate well with reported ACL/cartilage injury combinations from literature. This increased understanding will improve surgical procedures, and training programs can address the avoidance of harmful knee motions in athletes (2). References: (1) Boden, B. P., Griffin, L. Y., and Garrett, W., 2000. "Etiology and prevention of non-contact acl injury". *Physician Sportsmed*, 28(4), pp. 53–60. (2) Renstrom, P., Ljungqvist, A., Arendt, E., Beynonn, B., . . . , Krosshaug, T., et al., 2008. "Non-contact acl injuries in female athletes: an international olympic committee current concepts statement". *British Journal of Sports Medicine*, 42(6), pp. 394–412. Contact: ruben.goebel@qu.edu.qa



## RELATIONSHIP BETWEEN MECHANICAL CHARACTERISTICS OF THE PATELLAR TENDON AND BODY SIZE IN HUMAN

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**Introduction.** It was found previously that mammals with larger body size have stiffer tendons connected to extensor muscle groups compared to their smaller companions. The main aim of this study was to investigate the relationship between mechanical characteristics of the patellar tendon and body height and weight in human. **Methods.** 77 young recreational athletes (38 women and 39 men; age=20.95±1.33 yrs) participated to this study. The length of the patellar tendon was measured by ultrasonography (US) at 0, 20, 40, 60, 80 and 100% of the maximal voluntary isometric contraction in a computerized knee dynamometer at 60 degrees of knee joint angle. The length at the end of the toe region was also defined and deemed to be the rest length. Patellar tendon force was calculated by the torque divided by the tendon level arm based on corresponding data in the literature [1]. Stiffness was defined as the slope of the force-elongation curve. Strain value was calculated as a percentage of the elongation relative to the rest length. Length of the patellar tendon was validated by magnetic resonance imaging on 13 subjects. Relationship between the rest length, maximal elongation, body height and weight were tested by Pearson's correlation. Significance level was set at  $p<0.05$ . **Results.** Rest length of the patellar tendon was 49.6±5.0 mm. The use of US to measure patellar tendon length was supported by the validation (ICC=0.93). At maximal voluntary knee extension (193.8±62.1 Nm) the tendon elongated by 6.10±2.43 mm. The strain was 12.8±6.25%. Stiffness of the tendon was 820.5±364.2 N/mm. Rest length showed significant relationship with the body height ( $r=0.58$ ,  $p<0.001$ ). Stiffness correlated with body weight and height ( $r=0.49$ ,  $p<0.01$ ;  $r=0.42$ ,  $p<0.01$ ; respectively). Stiffness was inversely proportional to the maximal elongation ( $r=-0.48$ ,  $p<0.01$ ). **Discussion.** In previous studies the strain of different tendons in human varied between 3% and 13%. It shows that the elongation of the patellar tendon is relative high compared to other tendons in the body. Correlations between stiffness and body size suggest that the tendon adapts to the body weight and height which provide larger inertia at the knee joint. Tendons linked to extensor muscles seem to have larger stiffness that may be due to the continuous load in locomotion. Our results show that patellar tendon characteristics relate to the body size similar to the mammals in general, however the strength of the relationship suggest that other factors such as training can substantially alter the mechanical properties of the tendon. [1] Smidt, G. L. (1973). Biomechanical analysis of knee flexion and extension. *J Biomech* 6, 73-82. Contact: and.hegyi@gmail.com

## KINETIC CHARACTERISTICS OF KICKING MOTION BETWEEN FOOTBALL PLAYERS WITH OR WITHOUT GROIN PAIN – FROM MOTION ANALYSIS OF THE KICKING LEG AND THE TRUNK DURING INSTEP KICK-

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**【Introduction】** Although the incidence rate of groin pain among football players is said to be low, the treatment becomes challenging as it may become chronic once it develops. It has been reported that kicking motion relates to the groin pain. However, its mechanism is still unclear. The purpose of this study was to reveal the characteristic motion of kicking between football players with or without groin pain. **【Methods】** Eight players with the history of groin pain in the past year (GP) and nine players without the groin pain (NP) were included in the study. All the players kicked the ball 3 times to the target, which was 10 m away, by instep kick after total of 39 body markers (based on Plug-in gait maker set) were applied. Kicking motion was analyzed by three-dimensional motion analysis (Vicon T20x20; sampling 250 Hz) and mutually-synchronized force plate (Kistlerx1; sampling 1000 Hz) followed by analysis of the kicking leg and the stance leg using motion analyzing software Vicon Nexus 1.7. Analyzing interval was from the toe off of the kicking leg (TO) through the maximum hip extension of the kicking leg (MHE). **【Results】** The maximum flexion torque of the hip from MHE to BI in the kicking leg was not significant between the GP and the NP group. However, maximum knee extension torque to BI of the kicking leg in the GP group (164.14 ± 46.05 N/kg) was significantly higher than that of the NP group (113.26 ± 90.30 N/kg) ( $p<0.05$ ). Relative rotation angle of the upper and lower trunk in the GP group (9.1±6.4°) was significantly smaller than that of the NP group (19.2 ± 5.7°) ( $p<0.05$ ). Ankle dorsiflexion angle of the pivot leg was significantly smaller in the GP group (FC 13.2 ± 7.0° and BI 7.7 ± 13.2°) than that of the NP group (FC 19.7 ± 10.1° and 16.2 ± 10.2°) ( $p<0.05$ ). Average speed of the translation direction of the body mass center was significantly smaller in the GP group (during FC-BI 2.97 ± 0.30 m/sec) than that of the NP group (during FC-BI 3.19 ± 0.30 m/sec) ( $p<0.05$ ).

**【Discussion】** The distinctive point about instep kick in the GP group was that it depended on knee extension torque of the kicking leg and the rotation angle of the upper and lower trunk was less compared to the NP group. In addition, decreased average speed of FC to BI phase was observed compared to TO to FC phase, although average speed of the same phase increased in the NP group. These results may suspect that the groin pain occurrence may have a relationship with kinetic stress of the knee extensors, and motion depending on the kicking leg because of ineffective motion and decreased speed. Also, the fact that the ankle dorsiflexion angle was smaller in the GP group from FC to BI phase, body mass center maybe leaned backward compared to the NP group. **【Reference】** 1) Hölmich P. et al.(2004). *Br J Sports Med*, 38(4), 446-451. 2) Gilmore J. (1998). *Clin Sports Med*, 17(4), 787-793. 3) Lynch SA. et al. (1999). *Sports Med*, 28(2), 137-144. 4) Cetin C. et al. (2004). *Br J Sports Med*, 38, 223-224. **【Contact】** Kenji murakami, kens-m@lime.ocn.ne.jp

## ACCURATE EVALUATION OF JOINT FORCES AND MOMENTS IN WHOLE BODY JOINTS DURING GAIT USING WEARABLE INERTIAL MOTION SENSORS AND IN-SHOE PRESSURE SENSORS

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**Introduction** Integrated systems of optical cameras and force plates have been conventionally utilized for human motion analyses, including joint kinematics and kinetics, due to its accuracy. However, it is limited to the laboratory work space required by the camera and force plate system. To analyze the human motion of daily activities or sports outside of the laboratory, wearable systems consisting of inertial motion sensors and in-shoe pressure sensors have been recently developed. In this study, the joint forces and moments in whole body joints during gait were evaluated using a wearable motion analysis system consisting of an inertial motion measurement system and an in-shoe pressure sensor system. **Methods** Walking motions were captured from 5 healthy male subjects using wearable and conventional systems simultaneously. The wearable system consisted of MVN@ inertial motion capture system (Xsens Technologies, Netherlands) with 17 inertial and magnetic sensors and Pedar-X@ (Novel gmbh, Germany) in-shoe pressure system. The conventional system composed of Hawk@ digital system (Motion Analysis, USA) with 10 cameras and 4 MP4060@ force plates (Bertec Corporation, USA). In the wearable system, the orientations of each body segment, vertical component of ground reaction force and center of pressure data were recorded. The positions of 37 anatomical landmarks were then calculated from the orientations of body segments using the imple-

mented software MVN®. Inverse dynamic analyses were conducted using Matlab® with a dynamics model of the human whole body. Results The joint forces were strongly correlated between the wearable system and the conventional system with small normalized root mean squared error (NRMSE) values in all joints ( $r=0.71-0.99$ ;  $NRMSE=5.5\%-6.2\%$ ). The lower extremity showed significantly higher correlation ( $r=0.99$ ) than the trunk ( $r=0.80-0.81$ ) and the upper extremity ( $r=0.71-0.79$ ). The joint moments showed good agreement with strong correlations ( $r=0.70-0.98$ ) in all joints except the shoulder ( $r=0.49$ ). The NRMSEs of the joint moments were acceptable (8.0%-16.9%) in all joints except the shoulder (24.1%) and elbow (35.2%). Discussion The measurements of both the joint forces and joint moments in human whole body joints using wearable inertial motion sensors and in-shoe pressure sensors were feasible for normal motions with a low speed such as walking, especially in the lower extremity joints. The portability and mobility of this wearable system can provide wide applicability in both clinical and sports motion analyses. Contact [yoonhkim@khu.ac.kr](mailto:yoonhkim@khu.ac.kr)

## BALANCE RECOVERY AFTER RANDOM PERTURBATIONS – INTERACTION EFFECTS OF DIFFERENT STIMULUS VARIABLES

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Introduction Setups with translating platforms representing a realistic simulation of slips by generating external perturbations are used in balance research to investigate underlying mechanisms of compensatory responses (Blake et al. 1988). Previous studies have been executed in static, bilateral balance paradigms with predictable, univariate settings. However, most falls happen in transient phases during single limb support, influenced by interdependent variables such as unpredictable amplitude, velocity or direction of stimulus origin (Horak et al. 1997). To detect phasic and segmental neuromuscular characteristics and kinematic strategies of compensatory responses in a dynamic balance paradigm, this study aimed to assess interaction effects of direction, amplitude and velocity during randomly applied perturbations on center of pressure (COP) displacement, joint kinematics and electromyographic (EMG) activity. Methods While balancing on one leg on a free-swinging platform, randomly allocated surface translations varying in direction (anterior-posterior (ap), medial-lateral (ml)), amplitude (2vs.3cm) and velocity (1.1vs.1.8m/s) were analyzed in 20 subjects regarding COP displacement and velocity, ankle, knee and hip joint excursions and EMG activity during short (SLR), medium (MLR) and long latency response (LLR) of selected shank and thigh muscles. Results Phases: SLR and MLR were scaled to increased velocity; LLR was scaled to increased amplitude ( $P<0.05$ ). Segments: Phasic interrelationships were accompanied by segmental distinctions: distal muscles were used for fast compensation in SLR, proximal muscles responded in LLR ( $P<0.05$ ). Kinematics: Ankle and knee joint deflections compensated for ap perturbations, hip joint deflections were used to restore equilibrium after ml perturbations ( $P<0.05$ ). Discussion Outcomes provide evidence that amplitude- and velocity-induced phasic and segmental preferences exist to regain equilibrium after surface translation: muscles of the distal segment govern the quick, non-functional response, whereas muscles of the proximal limb serve as delayed stabilizers to functionally prevent falling (Gollhofer et al. 1989). Regarding the kinematic strategy, dependencies exist concerning perturbation direction: a distal strategy is used for ap stabilizations, whereas the proximal segment is used to compensate for perturbations in the frontal plane. In conclusion, interaction effects indicate that compensatory responses are based on complex processes including different postural strategies characterized by phasic and segmental specifications, precisely adjusted to the type of balance disturbance. References Blake AJ et al. (1988). *Age Ageing*,17(6),365–372. Horak FB et al. (1997). *Phys Ther*,77(5),517–533. Gollhofer A et al. (1989). *Neurosci Lett*,105(1-2),73–78. Contact [kathrin.freyler@sport.uni-freiburg.de](mailto:kathrin.freyler@sport.uni-freiburg.de)

## RESISTANCE TRAINING INDUCES BENEFICIAL BIOMECHANICAL ADAPTATIONS IN OLD TENDON RATS

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The ageing process causes significant reductions in functionality, especially the muscular system which in turn also affects the tendons, increasing the chances of injuries. One way to reduce this process is through exercise training. Thus, the aim of this study was to determine the effect of resistance training (RT) in tendons of aged rats. The animals were divided into four groups: young sedentary (YS,  $n = 5$ ), young trained (YT,  $n = 5$ ), old sedentary (OS,  $n = 5$ ) and old trained (OT,  $n = 5$ ). Trained rats were submitted to the climb protocol with progressive load for 12 weeks. After the training period, the calcaneal tendon (CT); superficial flexor tendon (SFT) and deep flexor tendon (DFT) were removed for biomechanical analyses. The results demonstrated that RT may be able to prevent progressive decrease in tendon function during ageing. Although RT has prompted significant biomechanical changes in trained aged rats, there was no increase in cross-sectional area, either a reduction in tendon stiffness. Therefore, the tendons are adapted according to the stimulus, in this case the OT showed better biomechanical responses when compared with OS. Thus, the RT may be an excellent strategy to maintain the tendon properties during ageing.

## THE EFFECT OF LOWER EXTREMITY MASSES AND VOLUMES ON THE BALANCE PERFORMANCE OF ATHLETES

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1: UUSBF (Usak, Turkey), 2: EUBESYO (Kayseri, Turkey), 3: NUBESYO (Nigde, Turkey), 4: KMSIUMYO (Kahramanmaraş, Turkey) Introduction Balance is a measure of whole body performance, which requires, in addition to motor output, three interacting sensory systems: the vestibular, visual and somatosensory system (Mergner and Rosemeier, 1998). Our study aims to investigate the effects of lower extremity mass and volume characteristics of elite athletes on the balance performances. Methods The study has included 42 elite athletes totally with an average age of  $23.45\pm 2.50$  years, average height of  $173.64\pm 6.96$  cm, average weight of  $79.55\pm 14.19$  kg and average body mass index of  $26.22\pm 3.06$ . The calf, femur, foot and leg volumes of the subjects included in the study have been determined by means of Frustum method (Sukul et al., 1993); however, calf, femur, foot and leg masses of the subjects have been determined by means of Hanavan method (Kwon, 1998). The balance performances of the athletes have been measured by using Biodex Balance System. The balance performances have been scored by double leg (DL) as dynamic and static. Dynamic balance performances have been measured in three levels as good, moderate and low. Results When the balance performances of volumes and masses of calf, femur, foot and leg of the athletes have been compared, a significant difference between oscillation indexes and static balances has not been detected ( $p>0.05$ ). When dynamic balance performances have been evaluated, it has been found that there is a significant difference in low-level balance test ( $p>0.05$ ), and a positive difference has been found between the masses and volumes of calf ( $r= .437$ ), femur ( $r= .609$ ), foot ( $r= .344$ ) and leg ( $r= .607$ ) in terms of good and moderate level of balance performances ( $p<0.01$ ,  $p<0.05$ ). Discussion According to the

results obtained, the masses and volumes of calf, femur, foot and leg of the athletes have affected the balance performances and, as the difficulty level of the balance performance increases, the lower extremity mass and volumes affect the balance performance much more. In conclusion, it has been found that lower extremity masses and volumes affect the balance performance of the athletes positively, and lower extremity mass and volumes are required to be improved enough in the branches that put an emphasis on balance. References Mergner T, Rosemeier T. (1998). *Brain Res Rev* 28: 118–135. Kwon YH. (1998). Modified Hanavan Model. 13.02.2015. <http://www.kwon3d.com/theory/bspeq/hanavan.html/>. Sukul DMKSK, Den Hoed, KS, Johannes, EJ, Van Dolder R, Benda E. (1993). *Journal of Biomedical England*. 15, 477-480. mustafa.akil@usak.edu.tr

### CHANGES IN ENERGY COST AND STRIDE PARAMETERS DURING A LONG DISTANCE EXERCISE IN RUNNING

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Introduction In running, biomechanical and physiological parameters change during the exercise (Candau et al., 1998 ; Hunter et Smith, 2007). But the relationships between these two categories of changes are not well known (Avogadro et al., 2003). Therefore, the aim of this study was to analyse relationship between changes in both energy cost (EC) and stride parameters (SP) during a long distance run. Methods 15 male athletes (age :  $34 \pm 9$  years old ;  $VO_{2max}$  :  $62 \pm 5$  mlO<sub>2</sub>/min/kg ; MAS :  $18,9 \pm 0,8$  km/h) realized a maximal effort test and, within  $7 \pm 2$  days, an exhaustive submaximal run at 80% of their maximal aerobic speed (MAS) on a treadmill. During this test, SP (contact time (CT), aerial time (AT), stride length (SL) and stride frequency (SF)), with Optojump Next system (Microgate), and physiological parameters (heart rate, lactate concentration, EC (from oxygen consumption)), were measured each five minutes from the start to the end of the exercise. Results During the run at 80% of  $VO_{2max}$  ( $15,1 \pm 0,5$  km/h ; time :  $87 \pm 25$  min ; distance :  $21 \pm 6$  km), as regards biomechanical parameters, only CT increased significantly (from  $0,208 \pm 0,02$  ms at the beginning to  $0,214 \pm 0,02$  ms at the exhaustion) during the exercise ( $p < 0,05$ ). The other SP didn't show any significant change during the submaximal test even if AT and SF tend to decrease while the SL tends to increase. As regards physiological parameters, only heart rate increases significantly (from 84% to 93% of maximum heart rate) while lactate concentration, EC, and therefore, oxygen consumption, increase but not significantly. No correlation have been found between SP and EC. Discussion The aim was to study the relationship between changes in the SP and the EC during a long distance exercise in running. We could hypothesize that fatigue generated by the intensity of the exercise could change the SP and thus, induce an CE increase. However, no correlation could be demonstrated. The disparity of results reflects the complexity of the influence of SP on RE. It would be interesting to further study by EMG analysis, especially during the phase of flight. This phase seems to have an influence on the energy cost (Santos-Concejero et al., 2014). References Avogadro P, Dolenc A, Belli A (2003). *Eur J Appl Physiol*, 90, 165-70. Candau R, Belli A, Millet GY, Georges D, Barbier B, Rouillon JD (1998). *Eur J Appl Physiol*, 77, 479-85. Hunter I, Smith GA (2007). *Eur J Appl Physiol*, 100, 653-61. Santos-Concejero J, Tam N, Granados C, Irazusta J, Bidaurragaga-Letona I, Zabala-lili J, Gil SM, (2014). *J Strength Cond Res*, 28, 1889-95. Contact : ddeflandre@ulg.ac.be

### A SCOTT BENCH WITH AN ERGONOMIC PROFILE IMPROVES POSTURE DURING ARM CURL EXERCISE

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Introduction: The barbell arm curl executed on Larry Scott bench (preacher arm curl) is a popular strengthening exercise for elbow flexor muscles. It is a single-joint, open kinetic-chain, auxiliary exercise, which allows a high degree of control over elbow kinematics (elbow alignment, range of movement, angular velocity and acceleration) and selective brachialis and biceps brachii strengthening, avoiding compensatory muscle activations. However, this exercise displays a drawback related to the exerciser posture. Indeed, the flat shape of Scott bench induces a considerable shoulder girdle protraction and an enhanced kyphotic curvature of the thoracic spine. The aim of this work is to assess whether an ergonomic design of the thorax pad can improve the posture maintained during the preacher arm curl exercise. Methods: We have designed and built up on a plated loaded machine (Purestrength by Technogym, Cesena-Italy) a curved ergonomic Scott bench to accommodate the thorax profile and improve the posture during the preacher arm curl exercise. Kinematic analysis and inclinometers were applied to measure shoulder protraction and thoracic kyphosis in 15 subjects performing a preacher arm curl with the machine provided by the classic flat pad. The same measures were repeated after replacing the flat pad with the new ergonomic one. Results: Compared to the standard flat pad, the new ergonomic pad decreased significantly ( $p < 10^{-3}$ ) both shoulder protraction (of about 4 cm) and thoracic kyphosis (of about 6 degrees). Discussion: The recorded postural changes induced by the ergonomic pad can, in turns, increase the sub-acromial space, improve the overall stabilization of the shoulder girdle, expand the rib cage, improve the breathing function, produce a natural decompression of inter-vertebral disks and facilitate a correct alignment of the cervical spine. Ultimately, the new ergonomic pad can significantly improve the poor posture induced by the standard flat Scott bench. References: Borstad JD. (2006). *Phys Ther*, 86, 549-557. Lewis SJ, Valentine RE. (2010). *BMC Musculoskeletal Disord*. 2010, 11-39. Neumann AD (2010). *Kinesiology of the musculoskeletal system*, 105-109. Mosby Elsevier, St. Louis, Missouri. Contact: pbenvenuti67@gmail.com

### THE EFFECT OF SOMATOTYPE CHARACTERISTICS OF ATHLETES ON THE BALANCE PERFORMANCE

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1: UUSBF (Usak, Turkey), 2: EUBESYO (Kayseri, Turkey), 3: KMSIUMYO (Kahramanmaraş, Turkey), 4: NUBESYO (Nigde, Turkey) Introduction Balance is fundamental in performing sport skills or even daily activities. Balance must be maintained before, during, and after performing the skill. Balance is a generic term that describes the dynamics of body posture in preventing falling (Rad et al., 2013). Our study aims to investigate the effects of somatotype characteristics of elite athletes on the balance performances. Methods The study has included 46 elite athletes totally with an average age of  $24.04 \pm 3.14$  years, average height of  $173.82 \pm 7.01$  cm, average weight of  $80.31 \pm 14.07$  kg and average body mass index of  $26.42 \pm 3.05$ . The heights, body weights, skinfold thicknesses, periphery and diameter of skinfold of the subjects included in the study have been measured and somatotype characteristics have been determined by using Heath-Carter method (Carter, 2002). The balance performances of the athletes have been evaluated by using Biodex Balance System. The balance performances have been determined as dynamic and static. Dynamic balance performances have been measured in three levels as first, second and third. It has been determined that the dynamic balance performance of the athletes has changed in accordance with the endomorph, mesomorph and ectomorph characteristics of the athletes; however, static balance performances have not changed. Results Accordingly, no difference has been observed between the oscillation indexes and static balances of the athletes ( $p > 0.05$ ), whereas

a significant difference has been found as the balance level increases in accordance with the endomorph, mesomorph and ectomorph characteristics of the athletes in terms of dynamic balances ( $p < 0.01$ ,  $p < 0.05$ ). Thus, the best balance scores belong to the athletes with endomorphic characteristics; the second best scores belong to athletes having mesomorphic characteristics and the lowest scores belong to the athletes with ectomorphic characteristics. Discussion According to the results obtained, the somatotype characteristics of the athletes affect the balance performances and the best results belong to the athletes having endomorphic characteristics followed by the athletes having mesomorphic and ectomorphic characteristics, respectively. In conclusion, it is assumed that the athletes having endomorphic characteristics may be more successful in the sports branches that put an emphasis on the balance. References Rad SL, Mamashi Z, Sadeghi H. (2013). Intl. j. Sport Std. Vol., 3 (10), 1137-1148. Carter, JEL. (2002). Somatotype Instruction Manual. San Diego State University, 7, 1-26. elif.top@usak.edu.tr

## BIOMECHANICAL PREDICTORS OF WRIST SHOT SUCCESS IN FLOORBALL

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**Introduction** Floorball is a recent sport that is becoming increasingly popular. There is lack of floorball specific biomechanical knowledge on its technical gestures to instruct coaches and to train players. The objective of this study was to identify biomechanical predictors for accuracy and speed of the wrist shot, comparing two different starting feet positions. **Methods** Ten floorball players (nine recreational and one elite) performed 2 series of 10 stationary wrist shots, in two different positions (FB: feet at a right angle to the end of the stick, oriented towards a target; LB: feet parallel to the end of the stick and to the target). A 12-camera motion capture system tracking reflective markers on key landmarks was used to record participant and stick kinematics. Accuracy of the shoot was quantified by distance of impact from target centre. Ball speed was measured at the same moment as accuracy. Player gaze was determined from head position. **Results** Regarding shot accuracy, results showed that FB position allowed a better accuracy than LB position (FB =  $0.25 \pm 0.01$  m ; LB =  $0.32 \pm 0.02$  m ;  $p = 0.007$ ). Regarding ball speed, there was no significant difference between the two positions (FB =  $22.43 \pm 0.58$  m•s<sup>-1</sup> ; LB =  $22.90 \pm 0.58$  ms<sup>-1</sup> ;  $p = 0.485$ ). More accurate players have a greater range in rotation of the head in relation to the thorax, coupled with practically non-existent absolute rotation of the head. Correlation coefficients suggested that ball speed was mainly influenced, in both positions, by the flexion of the supporting leg (ankle, knee and hip) and by the rotation of the trunk, especially for the angle formed by the pelvis and the shoulders (spine), just like in ice hockey or golf (Michaud-Paquette et al., 2011). **Discussion** The results suggest that feet position in floorball has an important influence on shot accuracy. Players' accuracy was significantly better when the feet were oriented towards the net. In a game situation, when the player is moving, this type of shot is more natural as it presents continuity with the running. The comparison between the recreational and elite players showed important differences in these technical skills. The best players settle their eyes on the target from the start to the end of the shooting movement. This strategy seems to allow better accuracy, provided that the player masters the technical skills necessary to control body and stick without visual aid. **References** Michaud-Paquette, Y., Magee, P., Pearsall, D., & Turcotte, R. (2011). Whole-body predictors of wrist shot accuracy in ice hockey: a kinematic analysis. *Sports Biomech*, 10(1), 12-21. Contact E-mail address: matteo.lazzeri@bluewin.ch

## EFFECTS OF THE LEVEL OF MUSCLE PRACTIVATION OF THE LOWER EXTREMITIES FROM DIFFERENT JUMP PATTERNS.

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**Introduction** Preactivation of muscle before eccentric phase might be a major factor enhancing SSC during a jump performance (Kallio, Linnamo & Komi, 2004). The different jump patterns may develop a different level of preactivation of the lower extremities muscle, and change kinetic and kinematic variables consequently. Therefore, the aim of this study is to investigate the relationship between the level of muscle preactivation and jump height as a result of jump performance. **Methods** Infrared cameras, a force platform and EMG were used to analyze the jump tasks of 10 male college students. The subjects were instructed to jump randomly on the force platform or jump box with a counter movement jump (CMJ), a drop jump from a jump height of the 40cm (DJ), and a counter movement jump including a preliminary jump (PJ). EMG activities and vertical ground reaction force (VGRF) and position data tracking the markers were measured. The integrated EMG (iEMG) of preactivation phase was calculated to show the level of the preactivation of lower extremity muscles. Repeated-measures ANOVA was used to compare three different jumps ( $p < 0.05$ ). **Results** The peak VGRF was significant increasing in DJ during the propulsive phase ( $p > 0.05$ ). There were no significant differences in jump height ( $p < 0.05$ ). The maximal angular velocity of a thigh in DJ were greater than CMJ and PJ during the propulsive phase, while the minimal angular velocity of a shank in CMJ was greater than DJ and PJ ( $p > 0.05$ ). The value of iEMG during preactivation phase showed only significant difference in Tibialis Anterior (TA) muscle ( $p > 0.05$ ). **Discussion and Conclusion** There was no improvement of the jump height, even though the peak VGRF in the DJ and the peak angular velocity of a shank and a thigh in the DJ and CMJ showed significant increasing during the propulsive phase. The change of level of preactivation was only found in the TA, contrary to expectation to be increased the activation value of Gastrocnemius muscle (Ruan & Li, 2010). The results indicated that the drop height and the preliminary jump preceding a main jump could not influence on the level of preactivation of the lower extremity muscles, improve the jump height during the jump performance in the same way. **References** Kallio, J., Linnamo, V., Komi, P. V. (2004). The effects of muscle history on short latency stretch reflex response of soleus muscle. *J Electromyogr Kinesiol*, 14(3), 411-421. Ruan, M., & Li, L. (2010). Approach run increases preactivation and eccentric phases muscle activity during drop jumps from different drop heights. *Journal of Electromyography and Kinesiology*, 20, 932-938. Contact jemshin@smu.ac.kr

## BIOMECHANICAL EFFECTS OF ELASTIC BANDS, CHAINS AND FREE-WEIGHT RESISTANCE ON SUBMAXIMAL BACK SQUAT EXERCISE

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**Introduction** Imposing variable resistance using elastic bands (EB) or chains (Ch) in addition to the free-weight resistance (FWR; i.e. the bar and weights) alters the loading characteristics of a squat lift. This can increase the range of motion through which substantial loading is applied, while maintaining the average load, thus reducing loading at the movement's 'sticking point'. The manipulation of the loading characteristics can enable the athlete to operate at near maximal levels for a greater proportion of the exercise, providing a greater training stimulus and thus may be a more effective training tool. The aim of the present study was to examine the biomechanical differences between EB, Ch and FWR during the submaximal squat exercise. **Methods** Fifteen strength-trained active men (age =  $26.9 \pm 7.9$  yr,

height =  $172.3 \pm 18.8$  m, mass =  $80.6 \pm 12.2$  kg) experienced in squatting (>3yr) volunteered for the study after giving written informed consent; ethical approval was granted from the University of Northampton. On three separate occasions the subjects performed FWR (control), EB or Ch (variable resistance) squat lifts for two sets of three repetitions at 85% 1-RM (35% of the load was generated from variable resistance). 3D motion analysis was used to record knee joint kinematics, and vastus medialis (VM), vastus lateralis (VL), rectus femoris (RF) and semitendinosus (ST) electromyograms (EMG) were recorded simultaneously. To reduce EMG variability (increasing the ability to detect significant differences), VL, VM, RF EMG data were averaged to represent quadriceps femoris (QF) EMG activity. Repeated measures MANOVA's were used to examine EMG and kinematic differences between conditions; significance was accepted at  $p < 0.05$ . Results No significant differences ( $p > 0.05$ ) in peak (1.8-2.8%) or mean eccentric (2.4-6.6%) and peak (3.5-4.0%) or mean concentric (5.0-6.0%) QF EMG activity were found between conditions. Similarly, no differences ( $p > 0.05$ ) in peak (5.8-14.3%) or mean (9.2-15.8%) eccentric and peak (8.9-9.6%) or mean concentric (1.2-1.7%) knee angular velocities, or peak knee flexion angle (1-1.5%) were observed. Discussion Performing the back squat exercise with the use of elastic bands or chains to provide 35% of the resistance compared to FWR alone at 85% of 1-RM did not alter knee extensor EMG amplitude or knee kinematics during the squat lift in either eccentric or concentric phases, and did not affect squat depth. Both significant and non-significant changes in kinematics, ground reaction forces and muscle activity have been previously reported in the literature; substantial differences in methodology likely explain these equivocal findings.

### ASSESSMENT OF ELBOW TORQUE-VELOCITY CURVE FITTING WITH DIFFERENT OPTIMIZATION CRITERIA

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**ASSESSMENT OF ELBOW TORQUE-VELOCITY CURVE FITTING WITH DIFFERENT OPTIMIZATION CRITERIA** Introduction This study concerns the elbow torque-velocity relationships of flexors and extensors. The aim was to compare four optimization criteria for assessment of the optimal fitting of these relationships with polynomials. Methods The isokinetic torque of the elbow flexors and extensors of ten females was obtained under six velocities ( $^{\circ}/s$ ): 0, 30, 75, 120, 150, 210. The least squares fitting (averages or cloud point data) of torque-velocity curves with 2nd to 4th order polynomials was assessed with Akaike information criteria (AIC), Bayesian information criteria (BIC), Minimizing the maximum residual (MMR) and Hausdorff distance criteria (HDC). The predictive relationships with the values of the optimal coefficients were also fitted. Results All criteria uniquely determined the 4th order polynomial as optimal for flexors (AIC = -89.09, BIC = -6.4, MMR, HDC = 0.36) and extensors (AIC = -76.04, BIC = 6.72, MMR, HDC = 1.3), when averages were used. The same conclusion was obtained by using point cloud data with the exception of BIC for extensors and AIC and BIC for flexors, where 2nd order was optimal. Non-physiological curvatures were obtained with polynomials of degree greater than 4. Discussion The graphics of polynomials from 2nd to 4th order were curvatures with acceptable behavior, similar to other authors (Ripamonti et al., 2008). AIC, BIC, MMR and HDC uniquely pointed out that the 4th order polynomial is an optimal model for elbow flexors and extensors, when fitting with averages, while with point cloud data AIC and BIC reveal different assessment. So, the AIC and BIC are less reliable, although commonly used, while MMR and HDC are rather novel (Mavrevski, 2014). However, in this study, the least squares fitting was used without constraints, and the graph of the 4th order polynomial is quite different from those of the classical force-velocity relationship (Hill, 1938). It remains an open question if the fitting method with constraints and polynomials will provide accurate physiological torque-velocity curves in elbow flexors and extensors, or it should be investigated with other (non polynomial) logistic equations (Looft and Law, 2013). References Hill AV. (1938). Proc. R. Soc. Lond., 126(843), 136-195. Looft JM, Law LF. (2013). Ann Meeting of ASB. Mavrevski R. (2014). CR ACAD BULG SCI, 67(10), 1345-1354. Ripamonti M, Colin D, Rahmani A. (2008). Clin Biomech, 23, 520-526. Acknowledgement. This work was supported by the project of the BNSF, code NSF I02/16, 12.12.14. Contact [ koroleova@abv.bg]

### Coaching

#### THE BILATERAL DEFICIT IN VERTICAL JUMPING IS AFFECTED BY BALANCE ABILITY IN YOUNG MALE ATHLETES

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Introduction Previous studies have shown that the height and muscle power achieved when jumping on one leg was 58.5% of that reached in two-legged jumps (van Soest et al., 1985). However, this "bilateral deficit" during vertical jumping is reduced or may even be absent in younger individuals (10-12 year old) and it was hypothesized that this may be related with the ability to balance on one leg (Veligekas and Bogdanis, 2013). Thus, the purpose of this study was to examine the relationship between balance ability and the extent of bilateral deficit. Methods Nineteen young athletes (age:  $19.4 \pm 1.5$  yrs, height:  $177 \pm 3$  cm, body mass:  $72 \pm 6$  kg) performed one- and two-legged countermovement jumps (CMJ) and the Flamingo balance test. Three trials were performed in each test with 1 min rest in between and the best result was taken for analysis. The bilateral jump deficit index was calculated as:  $1 - (\text{right} + \text{left leg jump height}) / \text{two-leg jump height} \times 100$ . Data were analyzed using Student's t-test and relationships were assessed using Pearson product-moment correlation ( $p < 0.05$ ). Results The average bilateral deficit index was  $-2.1 \pm 9.5\%$  for the whole group of athletes. However, ten participants showed a bilateral deficit, as shown by the negative bilateral deficit index ( $-9.0 \pm 6.4\%$ ), while the other nine did not exhibit bilateral deficit (bilateral deficit index  $5.5 \pm 5.6\%$ ). There was no difference between the right and left leg jump heights in all participants. The results of the Flamingo test were similar for the two legs ( $4.3 \pm 3.0$  vs.  $4.1 \pm 3.0$  falls), but falls were significantly higher in the group that showed bilateral deficit ( $2.5 \pm 2.2$  vs.  $6.1 \pm 2.6$  falls,  $p = 0.004$ ). A positive correlation was found between bilateral deficit index and the Flamingo test score ( $R^2 = 0.5449$ ). Discussion The results of the present study showed that a bilateral deficit in jumping may not be evident in some young male athletes. The finding that a large portion of the variance (54.5%) in bilateral deficit index is explained by the variance in the Flamingo Balance test score would suggest that bilateral deficit in jumping in young athletes may be masked by the ability to balance on one leg. Coaches should aim to improve leg balance in order to maximize jump training in young male athletes. References van Soest, AJ, Roebroeck, ME, Bobbert, MF, Huijing, PA, van Ingen Schenau, GJ (1985). Med Sci Sports Exercise, 17, 635-639. Veligekas P. and Bogdanis GC (2013), J Phys Educ Sport, 13(1), 120-126 Contact [gbogdanis@phed.uoa.gr]

## SELF-DETERMINATION IN SPORT: A STUDY OF BRAZILIAN RHYTHMIC GYMNASTICS ATHLETES

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**Introduction** The Self-Determination Theory (Deci, Ryan, 1985) states that self-determined athletes have higher intrinsic motivation, acting for the pleasure in the pursuit of their social, physical and psychological well-being (Ryan, Deci, 2007). This study aimed to evaluate the self-determination levels in athletes of Rhythmic Gymnastics. **Methods** The study included 47 athletes of Rhythmic Gymnastics, aged 13-16 years. For data collection, we used the 'Inventory of Self-Determination for Practitioners of Physical Activity and Sports' (IAPAFE-25) (Balbinotti and Barbosa, 2008), which assesses 5 levels of self-determination, each with 5 items, answered in a Likert scale, graduated in 5 points. Data normality was verified using the Shapiro-Wilk test. The average comparison was carried out using the paired t test. **Results** The descriptive analysis indicated that the mean ranged from 6.63 (amotivation) to 16.17 (Identified Regulation). The standard deviations associated ranged from 2.78 to 4.01 (so that they are suitable). Autonomy levels are distributed in three groups statistically different from each other ( $p < 0.001$ ): a) Intrinsic Motivation and Regulation Identified statistically undifferentiated averages ( $t = -1.63$ ;  $p > 0.05$ ); b) introjected regulation and external regulation formed a second group with statistically undifferentiated averages ( $t = -0.544$ ;  $p > 0.05$ ); c) amotivation, whose means were statistically lower than the others ( $p < 0.001$ ). **Discussion** The athletes evaluated presented, predominantly, more autonomous motivation levels, and significantly lower levels of amotivation. These levels are desirable in sports. **References** Balbinotti, M. A. A.; Barbosa, M. L. L. (2008) Inventário de Autodeterminação de Praticantes de Atividades Físicas e/ou Esportivas. Laboratório de Psicologia do Esporte. Universidade Federal do Rio Grande do Sul: Porto Alegre. Deci, E. L.; Ryan, R. M. (1985) Intrinsic motivation and self-determination in human behavior. New York: Plenum Press. Ryan, R. M.; Deci, E. L. Active Human Nature: Self-Determination theory and the promotion and maintenance of sport, exercise, and health. In: Hagger, M.S.; Chatzisarantis, N.L.D. (2007) Intrinsic motivation and self-determination in exercise and sport. Champaign. Human Kinetics. p. 1-19. Contact: patifontana@yahoo.com.br

## INFLUENCE OF DIFFERENT STRENGTH TRAINING ON RATING OF PERCEIVED EFFORT OF RUNNING

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Ratings of perceived effort (RPE) is an indirect technique utilized to monitor intensity of training. Several authors have been reported the importance of RPE for different physical activities as intermittent and continuous sports (REFERENCE). In this perspective, strength and endurance training have used RPE for obtain a similar intensity associated to the repetitions maximal (RM) and lactate concentration/heart rate, respectively. The aim of the present study was to compare RPE of recreational runners on running sessions subdivided in groups combined with different strength training programs (maximal and explosive) during 8 weeks (24 sessions). Furthermore, it were compared performance variables as maximal oxygen uptake ( $VO_{2max}$ ), running economy (RE), maximal heart rate (HRmax), deflection point of heart rate (HRDP) and velocity associated at the deflection point (vHRDP). It were selected thirty-two recreational endurance runners divided into three groups, which it were included a maximal strength training group (MAX,  $n = 11$ ), an explosive strength training group (EXP,  $n = 11$ ) and a control training group that performed only the endurance training (CON,  $n = 7$ ). An incremental test was performed to collect  $VO_{2max}$ , HRmax, HRDP and vHRDP. In a submaximal test was evaluated RE. Tests of repetition maximal (1 RM) and height of jump were evaluated to represent neuromuscular variables. These performance variables were collected pre and post-training. Training lasted 8 weeks with MAX and EXP groups performing strength and endurance training 5 times per week (3 for endurance and 2 for strength training in alternate days). Meanwhile, CON group performed only endurance training 3 times per week. During training, 30 min after each endurance training session were collected RPE based on Borg table adapted. A ANOVA one-way was applied to compare RPE in each training session between groups. Statistics data were performed on SPSS 22.0. **Results:** ANOVA results shown a significant difference in RPE 1 between MAX and EXP groups ( $p = 0.024$ ), for all others RPE sessions there were not differences ( $p > 0.05$ ). All outcome for endurance variables ( $VO_{2max}$ , RE, HRmax, HRDP and vHRDP) did not show differences between groups after 8 weeks. Meanwhile, neuromuscular variables presented diverse results, 1 RM was different for MAX group when compared before and after training ( $p < 0.01$ ). The height of counter movement jump (hCMJ) has remained similar between groups after training period ( $p > 0.05$ ). The RPE sessions presented difference in first session between MAX and EXP probably due to little adaptation to the Borg scale adapted. In accordance, RPE did not present significative differences during periodization. At the same time endurance performance variables did not show differences after 8 weeks of training between groups. Although MAX and EXP groups had a higher training volume, both did not were different with CON group. The training periodization did not influence RPE sessions, however it was not able to improve performance for the running.

## QUANTIFICATION AND ANALYSIS OF OFFENSIVE SITUATIONS IN SIDED GAMES IN SOCCER

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**INTRODUCTION** Playing soccer in reduced spaces has become particularly important, both for organised or spontaneous set-ups. This type of play offers a great deal of possibilities and combinations and gives players an increased level of interaction in the game. Nevertheless, players' need to interact with each other turns any defending or attacking situation into complex moves with a wide range of variables to be considered, in which the player is never isolated and must make the move that has the most positive impact on play. Therefore, the aim of this study was to identify the most relevant attacking moves from a technical and tactical perspective for each game format, age group and playing surface. **METHODS** 54 sided games played in three different formats (5v5, 7v7 and 9v9) and with two age groups (U9 and U14) were filmed at three soccer clubs in Spain. This study used the observational method; it is descriptive and is applied through well-prepared systematic quantitative observation in a natural environment. A key part of the method involved viewing the match recordings and logging moves that had been categorised beforehand. **RESULTS** The results show that there were significant variations depending on the game format, and the study will present a description and analysis of the aspects that had considerable influence on attacking moves in the different formats of sided games (5v5, 7v7 and 9v9). **DISCUSSION** The study has shown that there are more touches of the ball and attacking play in the smaller game formats (Sampaio and Maças, 2012); there was a higher frequency among the variables for attacking play (goals, shots on goal and balls entering the penalty area) in all age groups and playing surfaces in the smaller-sided games (5v5 and 7v7) than in the 9v9 format (Okihara et al., 2004). All of them are closely interrelated and change uniformly depending on the type of playing surface, game format and age group. Therefore, the variables cannot be seen as isolated moves but rather as part of a co-evolution. Therefore, one of the key considerations is choosing a format that gives the players a sense of freedom

which encourages their creativity and hence lets them discover the various play possibilities (Kelly and Drust, 2009), while being able to manage the spaces according to their technical, anthropometric and physiological characteristics (Rampinini et al., 2007). REFERENCES Kelly D, Drust M (2009). *J Sci Med Sport*, 12, 475-479. Okihara K, Kan A, Shiokawa M, Choi CS, Deguchi T, Matsumoto M, Higashikawa Y (2004). *J Sports Sci*, 22, 500-520. Rampinini E, Impellizzeri FM, Castagna C, Abt G, Chamari K, Sassi A, Marcora SM (2007). *J Sports Sci*, 25, 659-666. Sampaio J, Maçãs V (2012). *Int J Sports Med*, 33, 1-7.

### FACTORIAL STRUCTURE OF DECISION-MAKING ABILITY IN DRIBBLING PLAYS IN BASKETBALL

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Purpose: This study aimed to conduct decision-making ability tests for dribbling plays in various situations and to statistically clarify the latent structure of decision-making during such plays. Methods: Subjects were 158 university basketball players. We conducted decision-making tests by pausing videotaped basketball games during gameplay and asking subjects to choose the correct situational assessment or anticipate the next play. All videotaped game scenes were from the 63rd All-Japan College Basketball Championships. The test consisted of 75 questions including the following four decision-making processes based on 37 game scenes: 1) "Fundamental recognition of opponent's defensive style" (8 items), 2) "Selective attention to game situation" (14 items), 3) "Recognition and anticipation of game situation" (24 items), and 4) "Decision on play" (29 items). Correct responses were regarded as those chosen by at least three out of five qualified coaches. Factor analysis was applied to the 75 test items and the factorial structure was investigated. Furthermore, Quantification Theory Type One was conducted with each factor score as the dependent variable and position, athletic level and gender as independent variables; the influence of each independent variable on the decision-making ability factor was investigated. Results: Factor analysis was applied to 75 items. Four factors were extracted using a scree plot of their eigenvalues. After rotation, these factors were interpreted as follows: "F1: Decision-making ability during dribbling plays to try to break through the defense while cooperating with other teammates," "F2: Decision-making ability during dribbling plays on the left side of the court," "F3: Decision-making ability during dribbling plays on the right side of the court" and "F4: Decision-making ability during dribbling plays in open areas." For the influence of position, athletic level and gender on each factor, Quantification Theory Type One showed that for F1, the largest category weight range was found in athletic level (0.466) followed by position (0.367), and for F2, the largest range was found in gender (0.368) followed by position (0.328); no categories showed ranges of more than 0.3 in F3 and F4. When we focused on category weights of items with large ranges, in the athletic level of F1, regular (.297) was the largest category and was markedly different from bench (-.166) and other (-.169). Again, in gender for F2, male players (0.165) showed larger category weights than females (-0.203). Conclusion: Extracted decision-making ability factors were conceptually classified into two situations: "cooperating with other teammates" and "individual offensive plays." The latter was viewed from the standpoint of the sides of the court and from that of facing opponents. In addition, we found that the former was influenced by athletic level and position. A gender difference was found in F4.

### DIFFERENCES IN THE LANDING POSITIONS OF REBOUND BALLS BETWEEN ONE-HANDED AND TWO-HANDED THREE-POINT SHOTS IN BASKETBALL

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Introduction In basketball, three-point shots are taken with either one or both hands. The landing position of a rebound ball is influenced by the type of shot taken and the shooting angle. The present study investigated the influence of these two shooting techniques and shooting angle on the landing position of rebound balls. Methods Subjects were 8 male one-handed shooters and 8 female two-handed shooters from K University in Japan. The basketball court was divided into five directions ("top", "right wing", "left wing", "right corner", and "left corner"), which were divided by 36 degrees from the midpoint of the end line, and four distance areas ("near", "middle", "far", and "outside the two-point shot area"), which were divided by the distances of 2.15 m, 4.20 m, and 6.35 m. Subjects took 40 three-point shots from each of the five directions. We counted the number of unsuccessful shots that landed in each of the four areas. The differences of ratios between the landing positions of the one- and two-handed shots were examined using odds ratios (OR). The chi-square test and adjusted residuals (AR) were used to examine the relationship between the angles and distances of the landing positions based on area. Results Significant differences were found in the "near" (OR=1.276) from the corner, "near" (OR=1.276) from the top, and "near" (OR=1.903) from the wing areas, showing that the ratios of rebounds from one-handed shots were higher than those of two-handed shots in these two distance areas. A significantly higher AR than the expectation value was found for one-handed shots from the "near and top" (AR=3.670). However, two-handed shots showed a significantly higher AR (AR=3.721) for the "middle and wing on the opposite side," but not the "top." Discussion Results showed that more one- than two-handed shots landed near the basket. It is likely that two-handed shooters take shots from a tighter angle due to their inability to shoot from a distance, resulting in rebounds landing farther from the basket than those from one-handed shots. In addition, the arcs of shots thrown by two-handed shooters frequently moved from right to left. This was due to the difficulty associated with balancing the strength of both hands when shooting.

### A STUDY ON THE EFFECTIVENESS OF A NEW COACHING DEVICE FOR THE MOVEMENT COACHING

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It is important to conduct a study that examine how athletes understand movement effectively. In recent years, image devices such as VTR have been utilized in coaching. A player confirms one's movement immediately right after he performed a skill, and he can connect to movement correction. Image devices are useful and enable players to have movement images. It is critical to build the correct "movement conception" for the acquisition of technique (Grosser & Neumaier, 1982). Devices that build a movement image effectively have been already developed, and they help players to improve their performance. However, it may be said that the effectiveness of coaching devices still needs further inspection. In such a situation, we developed a new coaching device. It is a doll that can be displayed on a white board. The doll is made of magnets. The purpose of the present study was to examine the effectiveness of this specific coaching device to master the movement skills. The methods were: -to present how to make a magnet doll and introduce a way to coach using a new magnet doll, and -to inspect the effectiveness by conducting questionnaires and interviews to a player (or players) who is (or are) taught with the doll. The study found that the "movement conception" could be developed better by using this magnet doll. Therefore, it is concluded that the coaching method with our new device is effective to master the skill elements.

## ROLES OF GENETIC FACTORS IN ION OF THE VOLLEYBALL TALENT

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**Introduction** Inspired by the desperate state of Hungarian volleyball and the lack of results in previous years, the present study aims to discuss those methods - especially the genetic factors - that give the safest indication of success and allowing of the earliest selection and nurturing of the most talented. **Methods** 141 players of 5 girls' volleyball teams and 4 boys' volleyball teams in two age groups (13-14 and 15-16 years old) participated in our study. The data were obtained between November 2012 and March 2013. To examine genetic factors we took 24 body size which were used to analyse physique, predicted adult height, difference between biological and calendar age, and a test of motor skills (18 meters sprint, stuffed ball toss forward, stuffed ball roll back, sit-up, standing broad jump, standing jump with one hand, special running with change of direction), to measure speed and explosive arm-leg-trunk strength. **Results** The correlation of the anthropometric parameters and of the motor skill tests showed that most parameters had a significant connection to stuffed ball toss forward and stuffed ball roll back. The 18m sprint and special running with change of direction correlated positively, while standing jump with one hand showed negative correlation with skinfold values. Body build analysis showed that both boys and girls were of average central body type with higher endomorph values. The difference between biological and calendar age was considerable (over 1 year) in the case of only 7 children. The predicted adult height for both sexes lags behind that recommended for volleyball players: only 4 of the girls and 8 of the boys are predicted to reach the values recommended in the professional literature (at least 180 cm for girls, and at least 190 cm for boys). **Discussion** We found 13 players (5 girls and 8 boys) who performed very well on all test of motor skills and they had higher-than-average in 17 of the 24 anthropometric parameters. But just 2 girl's and 5 boy's from these players body build type and their predicted adult height match the criteria recommended by the professional literature. The mission of the Hungarian volleyball experts have to find children, whose genetic factors probably guarantee the future success. **References** Biróné Ilics K. (2009): Selection in playing volleyball. In: Hughes M., Dancs H., Nagyváradi K. (eds.): *Research in Sport Science. DataWin2*, Cardiff, 236-244. Bompa T. O. (1985): *Talent Identification. Sports. Science Periodical on Research and Technology in Sport*. Ottawa. 1-11. Petroski E. L. Fraro J. D. et al (2013): Anthropometric, morphological and somatotype characteristics of athletes of the Brazilian Men's volleyball team: in 11-years descriptive study. *Brazilian Journal of Kinanthropometry and Human Performance*. 15 (2). 184-192. Contact ilicskati@mnsk.nyme.hu

## DEVELOPING A PSYCHOLOGICAL COACHING MODEL FOR UNIVERSITY BASEBALL ATHLETES —STRUCTURAL EQUATION MODEL WITH TEAM ADAPTATION AND MAL-ADAPTATION AS MEDIATOR VARIABLES—

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**Introduction** Higher evaluated coaches lead higher athletes' performance in all sport. In sport, coaches are asked for high competitive strategies, instruction skills, team leading competency and student-athlete mental health support. Prior studies have found that positive evaluation of baseball coaching by college baseball athletes is positively associated with their collective efficacy (Shimizu & Miyazaki, 2011), and negatively associated with athletic burnout (Shimizu & Miyazaki 2014). The purpose of this study was to develop a psychological coaching model for baseball athletes with Coaching Evaluation Scale for Baseball (CESB), Team Adaptation Scale for Baseball Athletes (TASBA), Team Mal-adaptation Scale for Baseball Athletes (TMSBA) and Subjective Performance Scale for Baseball Athletes (SPSBA). **Methods** The subjects of 264 baseball athletes (mean age=19.45, SD=0.89) in four high competitive university baseball teams were asked to answer a questionnaire composed of question items on socio-demographic background as well as eight-factor with 48 question items of CESB, one-factor with 6 question items of TASBA, three-factors with 18 question items of TMSBA and one-factor with 12 question items of SPSBA. These four scales had been developed in our prior studies from 2010 to 2014. Covariance structure analysis was conducted in order to examine our hypothetical psychological coaching model. **Results** The results of covariance structure analysis showed that the hypothetical model had statistically acceptable structural validities (GFI=0.987, AGFI=0.737, CFI=0.976, RMSEA=0.185). In the model, the path coefficients from CESB to TASBA (0.37,  $p<0.001$ ) and from CESB to Escape from Practice (EP) of TMSBA (-0.25,  $p<0.001$ ) were statistically significant while the path coefficient from CESB to Absent from Club Activities (ACA) of TMSBA (-0.06, ns) and Conflict of Human Relationships (CHR) of TMSBA (0.05, ns) were not statistically significant. The path coefficients from TASBA to SPSBA (0.39,  $p<0.001$ ) and from ACA to SPSBA (0.17,  $p<0.05$ ) were statistically significant while the path coefficient from EP to SPSBA (0.11, ns) and from CHR to SPSBA (0.11, ns) were not statistically significant. **Discussion** The results of the hypothetical model above have some implications for baseball coaching interventions. High coaching evaluation from baseball athletes is positively associated with high subjective performance only via high team adaptation. This implies that coaching with focus on building mutual trust among team members, teams' confidence in their success, and promoting a sense of accomplishment and enjoyment for practice is more likely to lead to better baseball performance.

## ABILITY FOR CHANGE OF DIRECTION PERFORMANCE WITH THE REACTIVE AND DECISION-MAKING IN SOCCER PLAYERS

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**Introduction** Agility is an essential component in most field and team sports. More recently it has been suggested that agility contains both a change of direction movement and a perceptual and decision-making component, since changes of direction and speed are often performed in response to an opponent's actions. However, there is few studies evaluating the capabilities to integrate the change of direction performance and perceptual decision-making as the target soccer players. The purpose of this study was to consider the reactive and decision-making ability in the change of direction performance of soccer players between the disciplines and competition levels. **Methods** University soccer players (n=30) and university track-and-field athletes (n=9) took part in the study, categorized into either a higher performance group (HPG) (n=15) or lower performance group (LPG) (n=15) and university track-and-field athletes (n=9). The evaluation of the ability for change of direction performance with the reactive and decision-making was used 20m sprint and a 20m sprint cutting to 90° reactive agility test (CUT90-RAT). CUT90-RAT arranged in the point to make a decision about whether to right or left turn according to light stimulation at 2.5m, 5m and 7.5m were conducted using electric timing gates (smart-speed). To assess the change of direction performance (CODP), the difference between CUT90-RAT 5m time and CUT90-RAT 7.5m time was calculated as follows:  $CODP = (7.5m\ time - 2.5m\ time) - (5m\ time - 2.5m\ time)$  **Results** The 20m sprint time, CUT90-RAT 2.5m time, CUT90-RAT 5m time and CUT90-RAT 7.5m time of track-and-field athletes were significant faster than that of HPG and LPG ( $p<0.05$ ). There was not significant



difference between HPG and LPG. CODP is as follows: track-and-field athletes 0.194 (sec) (5.1% slower) > LPG 0.187 (sec) (4.5% slower) > HPG 0.156 (sec) (3.8% slower). Discussion This study suggested that sprint speed itself gave to ability for change of direction performance with the reactive and decision-making was small influence. Good players have a sense of stability to the reactive and decision-making during the change of direction running. In addition, they have been skilled in the ability to adjust the sprint velocity even when the ability to reactive and decision-making has been limited to their stimulus. Reference 1. Young WB, James R, Montgomery I. Is muscle power related to running speed with changes of direction? *J Sports Med Phys Fit* 2002;43: 282–8. Contact maehana0608@gmail.com

### **CORRELATION BETWEEN 400-M SPRINT PERFORMANCE AND MAXIMAL ACCUMULATED OXYGEN DEFICIT IN DIFFERENT EXERCISE MODES**

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Introduction Approximately 60% of the energy available during 400-m sprint running depends on an individual's anaerobic capacity (Duffield et al., 2005). The Wingate Anaerobic Test (WAnT) is widely used to evaluate anaerobic power and capacity (Bar-Or, 1987). And then, the output power in the WAnT is known to reflect 400-m performance. However, differences in exercise modes have not been considered. Therefore, the aim of this study was to investigate the correlation between maximal accumulated oxygen deficit (MAOD) in running and cycling exercises and the accumulated oxygen deficit during WAnT and 400-m sprint running performance. Methods Fourteen male track and field college athletes (8 sprinters [400-m sprint performance: 49.29 ± 1.27 sec.] and 6 decathletes [50.29 ± 1.27 sec.]) participated in this study. The difference in MAOD of running and cycling was determined by using a supramaximal constant load test (Medbø et al., 1988). Moreover, they performed the WAnT by using an electromagnetic brake cycle ergometer, and the peak power, mean power, and accumulated oxygen deficit were determined. The applied resistance was 7.5% of body weight, and the duration was 60 seconds. The oxygen uptake during each test was recorded by using a breath-by-breath method. The subjects' season-best records were used for their 400-m sprint performance. Results The differences in MAOD between running and cycling and the accumulated oxygen deficit on the WAnT were insignificant. However, there were significant correlations between MAOD in running and cycling ( $r=0.70$ ,  $p<0.05$ ). In all the subjects and in the sprinters, there were significant correlations between the 400-m performance and MAOD in running (respectively:  $r=-0.65$ ,  $p<0.05$ ;  $r=-0.81$ ,  $p<0.05$ ), but not between performance and MAOD in cycling. In the sprinters, there were significant correlations between the 400-m performance and the mean power on the WAnT ( $r=-0.79$ ,  $p<0.05$ ). Discussion These results suggest that the applicability of the test for evaluating the anaerobic capacity of sprinters differs between running and cycling exercises. In the measurement of physical fitness levels by using cycling exercise mode, the technical factors of sprinting and each athlete's physical status require consideration. References Duffield, R., Dawson, B. and Goodman, C. (2005) Energy system contribution to 400-metre and 800-metre track running. *J. Sports Sci.* 23(3): 299-307. Bar-Or. (1987). *Sports Med*, 4, 381-394. Medbø, J. I., Mohn, A. C., Tabata, I., Bahr, R., Vaage, O. and Sejersted, O. M. (1988). *J Appl Physiol*, 64, 50-60.

### **Health and Fitness**

#### **DEVELOPMENT OF HEALTH INDEX FOR SUCCESSFUL AGING IN ELDERLY PEOPLE**

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The purpose of this study was to investigate the longevity age for the assessment of health and functional status in older adults based on 31 physical and physiological variables. One hundred thirty eight Korean men and women (aged 65-89 yrs) were recruited for this study. All subjects were free of any signs or symptoms of overt coronary heart disease, based on a health history questionnaire and were considered in good health. Body composition, blood pressure, blood lipid profiles were measured and physical fitness tests for the living were performed. The variables for assessing the physical fitness and cardiorespiratory fitness could be used to determine to evaluate the physical fitness for the living in older population. The blood lipid profile is useful to evaluate the metabolic syndrome and the VO<sub>2</sub>peak could be used to evaluate the respiratory fitness for the living. Ten principle factors were used to compute the longevity age in the subjects. Equation for calculation the longevity age is  $77.794 - 2.568 \times \text{sex} - 0.269 \times \text{age} + 0.093 \times \text{grip strength} + 0.122 \times \text{arm curl} - 0.170 \times \text{walking around two cons} + 0.221 \times \text{standing up and sitting down a chair} + 0.094 \times \text{functional reach} - 0.005 \times \text{total cholesterol} + 0.003 \times \text{low density lipoprotein cholesterol} + 0.292 \times \text{body mass index} + 0.075 \times \text{systolic blood pressure} - 28.907$  [ $R^2=0.694$ ]. The chronic disease and physical activity status showed excellent correlation with the longevity age in our study. In conclusion, this study may suggest that the equation derived for computing the longevity age applies to the assessment of the effectiveness in regular exercise older population as well as chronic disease patients. In addition, this equation will be a good index to improve and maintain the physical fitness for the living in older adults.

#### **INFLUENCE OF SUPERVISION RATIO IN RESISTANCE TRAINING ON CYTOKINES PARAMETERS OF THE ELDERLY WOMEN.**

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Resistance training (RT) has promote some improvements in health of older individuals and some variables may be control to improve benefices. Moreover, recently it has been show that direct supervision and supervision ratio (SR) also influence resistance-training benefices. However, there is absence about influence of SR in cytokines parameters. Thus the objective of this study was verify the effects of very high SR on cytokines parameters (Irisin, IL-1β and IL-15), Brain-derived neurotrophic factors (BDNF) and toll-like receptor 4 (TLR-4). Older individuals were divide in two exercises groups. Very high supervision (VHS) group that had one trainer to two individuals and high supervision group (HS) that had one trainer to five individuals. The training consist in whole body RT with three sets between eight to twelve maximal repetitions. BDNF, IL-1β, IL-15, irisin and TLR-4 blood markers were assess by using commercially available enzyme-linked immunosorbent assay (ELISA) kits. To Irisin a two way ANOVA was apply and to TLR-4, BDNF, IL-1β and IL-15 a Wilcoxon and Mann-Whitney analysis were apply. An alpha level less than 0.05 was considered. For both groups, no differences between baseline and post-training ( $P > 0.05$ ) were identify for Irisin (215.05 ± 70.58 to 207.29 for VHS and 219.63 ± 53.24 to 209.10 ± 58.04), TLR-4 (8.31 ± 5.76 to 7.30 ± 6.83 for VHS and 5.62 ± 2.70 to 5.24 ± 1.86 for HS), BDNF (1481.57 ± 183.57 to 1601.28 ± 116.38 for VHS and 1601.28 ± 116.38 to 1654.87 ± 75.84

for HS) and IL-15 ( $316.08 \pm 298.03$  to  $252.65 \pm 198.87$  for VHS and  $260.06 \pm 366.72$  to  $269.38 \pm 375.02$  for HS). Only for IL-1 $\beta$  the VHS group the serum levels decreased when compared with baseline ( $13.86 \pm 27.03$  to  $12.99 \pm 26.30$  for VHS;  $P = 0.002$ ). In this sense, it is possible to conclude that RT with VHS was able to improve IL-1 $\beta$ . However, in relation to other parameters RT program showed no significant difference independently of SR.

### **AFFECTIVE RESPONSE DURING A SINGLE BOUT OF HIGH-INTENSITY INTERVAL EXERCISE BETWEEN PHYSICALLY ACTIVE AND INSUFFICIENTLY ACTIVE MEN**

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**Introduction** Feeling of pleasure during exercise is determinant of physical activity participation and adherence. It is well established that high-intensity interval training (HIIT) results in a host of physiological adaptations including improvements in health and fitness (Gillen & Gibala, 2014). However, seems to be important to examine how individuals with different physical activity levels perceive this exercise model regarding to affective response. The aim of this study was to examine the affective response during a single bout of low-volume HIIT between sufficiently and insufficiently physically active men. **Methods** Thirty-two males (aged  $25.1 \pm 3.8$  years) participated in this study. Subjects were separated into two groups: i) insufficiently active ( $n=16$ ) and ii) physically active ( $n=16$ ). A maximal exercise test was performed to determine the peak treadmill velocity (PTV). The HIIT protocol consisted of 10 sets of 60s "work bouts" at 90% of PTV interspersed with 60s of active recovery at 30% of PTV. In the last 10s of each "work bout", the subjects reported their affective response (Feeling Scale, +5 to -5) and rating of perceived exertion (RPE, 6-20). **Results** The insufficiently active group had lower Feeling Scale (FS) values compared to the physically active group ( $p < 0.05$ ). There were no differences in RPE between the groups ( $p > 0.05$ ). Regardless of the physical activity level, there was a strong negative correlation between the RPE and FS values during the "work bouts" of the HIIT. **Discussion** Our results revealed that even with a less strenuous model of HIIT the subjects reported a decrease in FS values over time, similar to observed by Oliveira et al. (2013) and Jung et al. (2015). From a practical point of view, pleasant exercise can improve adoption and adherence to prescribed exercise programs and may enhance future exercise behavior (Garber et al., 2011). In this sense, we suggest that HIIT should not be used as a main exercise model for beginners during physical activity programs. This preliminary data support the idea that current physical activity level influences the feelings of pleasure/displeasure during a single bout of low-volume HIIT. Therefore, despite the physiological benefits of HIIT in improving health status and fitness it is important to consider that this mode of exercise is likely to be experienced as unpleasant, especially for less active individuals. **References** Gillen JB, Gibala MJ (2014). *Appl Physiol Nutr Metab*, 39, 409-12. Oliveira BRR, Slama FA, Deslandes AC, Furtado ES, Santos TM (2013). *PLoS One*, 8, 1-6. Jung ME, Bourne JE, Little JP (2014). *PLoS One*, 9, e114541. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee I-M, et al. *Med Sci Sports Exerc* 43: 1334-59. Contact ecc.ufrn@gmail.com

### **EFFECTS OF THE "NATIONAL EXERCISE REFERRAL SCHEME" IN TAIWAN TO PROMOTE PHYSICAL ACTIVITY AND PHYSICAL FITNESS IN ADULT.**

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**Introduction:** Despite the health benefits of physical activity is evident, most adults do not take the recommended amount of exercise. A novel "National Exercise Referral Scheme" (NERS), initiated by the Sports Administration, Ministry of Education, Executive Yuan, Taiwan was commenced in 2011 to encourage regular exercise participation in adults. This study aimed to investigate the effects of NERS in Taiwan to promote physical activity and physical fitness in adults with chronic conditions. **Methods:** This is a multi-center, one-group pretest-posttest study design. Subjects were recruited from the participants of NERS in Taiwan. People possessing the following chronic conditions would be qualified to enroll the NERS, including: metabolic syndrome, frail elders, and tendency toward melancholy, medically stable stroke, medically stable osteoarthritis, medically stable cardiovascular disease or anyone requiring encouragement to become physically active. The participants received a supervised class-based exercise program for, 30-45 minutes per session, at least 2 times per week. Outcome measures include 2 main categories: 1) Physical fitness (body composition, muscle strength, muscle flexibility and cardiovascular fitness); and 2) Questionnaires (self-report physical activity, quality of life, exercise motivation). Measurements were conducted at baseline and 12 weeks. **Results:** This study recruited 413 people who enrolled the NERS from 11 community exercise centers, with 70.6% female and mean age 48.9 years. After 12 weeks, positive results were found in physical activity level ( $988.3 \rightarrow 2243.3$  Kcal/week, medium effect size,  $P < .001$ ), health-related quality of life ( $0.69 \rightarrow 0.79$ , medium effect size,  $P < .001$ ), exercise motivation ( $33.3 \rightarrow 37.0$ , trivial effect size,  $P < .001$ ), exercise self-efficacy ( $7.58 \rightarrow 8.00$ , small effect size,  $P = .025$ ), as well as all physical fitness measures ( $P < .001$ ). **Discussions:** Our research found that NERS could effectively improve participants' physical fitness, quality of life, exercise motivation and physical activity level, especially for the clients with metabolic syndrome, knee osteoarthritis, osteoporosis and tendency toward melancholy. The program was considered to be worthwhile for wider implementations; nevertheless, rigorous evaluations of their effectiveness by randomized controlled clinical trial are required in the future. **References:** 1. Williams NH, Hendry M, France B, Lewis R, Wilkinson C. Effectiveness of exercise-referral schemes to promote physical activity in adults: systematic review. *Br J Gen Pract*. 2007;57(545):979-86. 2. Duda JL, Williams GC, Ntoumanis N, Daley A, Eves FF, Mutrie N, et al. Effects of a standard provision versus an autonomy supportive exercise referral programme on physical activity, quality of life and well-being indicators: a cluster randomised controlled trial. *Int J Behav Nutr Phys Act*. 2014;11:10.

### **THE EFFECT OF AGE AND GENDER ON PHYSICAL FITNESS IN CHILDREN**

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**ABSTRACT Introduction** – The aim of this study was to identify the effect of gender and age on some anthropometric variables and two fitness tests (20m shuttle run test and countermovement jump; MSFT and CMJ) in secondary schoolchildren of Kosovo country. **Methods:** In this cross-sectional study we treated 80 schoolchildren of both genders (40 boys 40 girls), who were further divided into two age groups. The groups which were tested were: male grade 7th ( $12.8 \pm 0.4$  years old), female grade 7th ( $12.66 \pm 0.2$  years old), male grade 9th ( $14.53 \pm 0.2$  years old), and female grade 9th ( $14.66 \pm 0.3$  years old). The following parameters were tested: height, weight, Body Mass Index, waist circumference, hip circumference, two skin folds (triceps and calf), % body fat, 20m shuttle run test (MSFT) to measure cardiorespiratory fitness, and Countermovement jump (CMJ) to measure lower body power. **Results:** Based on our results there was a

significant effect between genders and between ages in height and weight; there was no significant difference among groups for BMI, whereas there was a significant effect between genders regarding the waist circumference parameter. Similarly a significant effect of gender and age was found in terms of hip circumference, CMJ and 20m shuttle run test (MSFT) Conclusion: In conclusion, the present study recorded in an ample size of sample the somatic and fitness traits of 12 and 14 years old Kosovarian girls and boys. Overall, with the exception of aerobic power the observed data are satisfactory and comparable with the data of other developed states. Reference: Robert M. Malina, Claude Bouchard, Oded Bar-Or; Growth, Maturation, and Physical Activity second edition. Human Kinetic 2004. American College of Sports Medicine. Health-Related Physical Fitness Assessment Manual. Philadelphia, 2005. Lippincot Williams& Wilkins. U.S.DEPARTMENT OF HEALTH AND HUMAN SERVICES. Physical Activity Advisory Committee Report, 2008 (<http://www.health.gov/paguidelines/pdf/paguide.pdf> (accessed 10 February 2014)). L.A. Legar, D. Mercier, C. Gadouryl and J. Lambert: The multistage 20meter shuttle run test for aerobic fitness. Journal of Sports Sciences, 1988, 6, 93-101 Neil Armstrong; Aerobic Fitness and Physical Activity in Children. Pediatric Exercise Science, 2013, 25, 548-560. 2013. Email: ximi\_zaim@hotmail.com

## RELATIONSHIP BETWEEN ENVIRONMENTAL FACTORS AND PHYSICAL ACTIVITY IN CHINESE OLDER ADULTS

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Background: Physical inactivity has strong relation with mortality and morbidity in older adults. Currently, about 50% old adults in Taiwan are physically inactive. As age increases and function decreases, old adults tend to be more hypersensitive to environmental challenges and constraints. The environmental impacts may have more influence on their physical activity (PA) and health condition when compared with other ages. However, the relations between PA and environment in older adults have not been clearly identified yet. The majority of related studies are conducted only in North American and Europe areas, and rare in Asia, where the aging population has increased rapidly. Therefore, the purpose of this study is to investigate the relationships between environmental factors and PA in older adults in Taipei and to find the key factors of them. Method: Subjects of this project were the older residents ( $\geq 65$ ,  $N=325$ ) in Taipei City. It is based on the design of International Physical Activity Environmental Network Senior (IPEN Senior). We selected the survey areas by high and low city walkability index (measured by Geographic Information System) and social economic status (SES). We used accelerometers recording (objective PA measures) and International Physical Activity Questionnaire (subjective PA measures) as the main PA outcomes, and used GIS-based walkability indices (by 500m buffer) as the environment factors. In addition we used 3 physical functioning tests as the health variables to check the influence of lower body function in this issue. The data were analyzed with Pearson product-moment correlation, and generalized linear model. Results: The study recruited 325 participants, with mean age 72.3 years and 57.85% female. The amount of objective PA was categorized into moderate/vigorous-intensity PA (MVPA), high-light PA (HLLPA), and low-light PA (LLPA). Male, less age, and better agility of lower body are significantly related with more MVPA. Less age and better walking speed are significantly related with more HLLPA. Female, less age, and better muscular endurance of lower body are significantly related with more LLPA. Subjective PA outcomes are subjective MVPA, transport walking and leisure time walking. More subjective MVPA is significantly related with less public recreation amenities. More transportation walking is significantly related with female, less public transit, and less barriers. More leisure time walking is significantly related with better agility of lower body, less public transit, and less barriers. Conclusions: This study showed that the active older adults living in high population density Asian communities are limited by personal characteristics rather than walkability factors. However, the results showed that people with more age have less PA and more health risks, so we still need to clarify the relation between PA and other supporting environment, like health promotion resources, health management services, or health care services.

## ATTENUATED GLUCOSE HOMEOSTASIS IN SIMVASTATIN TREATED PATIENTS MAY BE CAUSED BY DECREASED LIPID SYNTHESIS CAPACITY IN SKELETAL MUSCLE

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Introduction A prevalent side-effect of the cholesterol-lowering drug Simvastatin is attenuated glucose homeostasis (insulin resistance). However, the underlying mechanism is unknown, but muscle lipid metabolism has previously been associated with insulin resistance (lipotoxicity). Hence, it is possible that Simvastatin-induced alterations of muscle lipid metabolism may lead to lipotoxic inhibition of insulin signaling. Therefore, our hypothesis was that patients treated with Simvastatin have lower content of the major proteins regulating uptake, synthesis, and storage of lipids and lipolysis in skeletal muscle than matched controls. Methods Ten men with hypercholesterolemia ( $45 \pm 2$  years,  $93 \pm 4$  kg, HbA1c:  $5.7 \pm 0.1\%$  and  $VO_{2max}$ :  $38 \pm 1$  O<sub>2</sub>/min/kg), treated with Simvastatin for more than 1 year (10-40 mg/day; 10 mg/day,  $n=1$ ; 20 mg/day,  $n=4$ ; 40 mg/day,  $n=5$ ), and ten healthy men as control ( $45 \pm 1$  years,  $91 \pm 4$  kg, HbA1c:  $5.2 \pm 0.1\%$  and  $VO_{2max}$ :  $40 \pm 2$  ml O<sub>2</sub>/min/kg) were included. An oral glucose tolerance test was performed and a biopsy was obtained from vastus lateralis. Western blotting was used to assess protein content in lipid uptake (CD36, LPL, DGAT 1 and 2), plasma membrane-associated fatty acid binding protein (FABPpm), and endothelial lipase (EL), lipid synthesis (diacylglycerol acyltransferase 1 and 2 (DGAT 1 and 2)), lipid storage (perilipin 2, 3 and 5) and lipolysis (adipose triglyceride lipase (ATGL) and hormone-sensitive lipase (HSL)). Results The groups did not differ in age; weight; body-mass-index; body fat (total and abdominal); maximal oxygen uptake ( $VO_{2max}$ ) or in; plasma TG, cholesterol, LDL and HDL. However, glucose homeostasis measured by the Cederholm index was lower in the Simvastatin-users compared with the control subjects. Protein content of CD36, LPL, DGAT 1 and 2 ( $P = 0.07$ ) were lower in patients treated with Simvastatin. With no differences in the other proteins related to: lipid uptake (FABP, endothelial lipase), lipid storage (perilipin 2, 3 and 5) or lipolysis (ATGL and HSL). Discussion The Simvastatin treated patients had an inferior capacity to recruit exogenous fatty acids (FA) and to synthesize FA and diacylglycerol (DAG) into triacylglycerol in skeletal muscle compared to matched controls. The decreased lipid synthesis capacity may lead to greater cytosolic levels of intermediates from lipid metabolism (FA and DAG) that causes lipotoxicity and hence attenuation of glucose homeostasis. The results add knowledge to our understanding of the molecular mechanism behind attenuated glucose homeostasis induced by chronic use of Simvastatin. Contact: avhansen@sund.ku.dk

## EFFECT OF MODERATE AND HIGH INTENSITY INTERMITTENT ENDURANCE EXERCISE ON POST EXERCISE HYPOTENSION

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**Introduction** Following endurance exercise, blood pressure is reduced compared to rest and knowledge about post exercise hypotension (PEH) is important in designing first line strategies against hypertension. National guidelines for prevention and treatment of hypertension recommend 30 min. of moderate intensity exercise (MOD) at ~50-80% of HFmax (Borjesson, 2008). The hemodynamic load during high intensity intermittent exercise (HIIT) is, however, larger compared to MOD, which in turn may affect the PEH response. The present study investigates the acute effect of MOD and HIIT exercise on PEH. **Methods** Six adults performed one bout each of 28 min. MOD and HIIT bicycle exercise. MOD exercise was at 80% of HFmax, while HIIT exercise was 4x4 min at 94% of HFmax, with 4 min recovery intervals at 80% of HFmax. Mean arterial pressure (MAP), cardiac output (CO) and systemic vascular resistance (SVR) was measured at REST, at termination of exercise (TEXC), 30 and 60 min. postexercise (PEXC30, PEXC60). **Results** REST MAP, CO and SVR values were 85(8) mmHg, 5.2(0.4) L min<sup>-1</sup>, and 1235(158) dyn s cm<sup>5</sup>. TEXC values for MOD and HIIT were 122(6)\* and 130(11)\*, # mmHg, respectively (\*compared to REST; p<0.03, #MOD compared to HIIT; p<0.04), 14.7(2.8)\* and 15.9(2.6)\* L min<sup>-1</sup>, respectively (\*compared to REST; p<0.03), 476(62)\* and 438(93)\* dyn s cm<sup>5</sup>, respectively (\*compared to REST, p<0.03). PEXC30 MAP, CO and SVR values following MOD and HIIT were 84(8)&, \$ and 84(6)&, \$ mmHg, respectively (&compared to TEXC, \$compared to REST; both p<0.03), 5.5(1.4)& and 6.6(1.5)&, \$ # L min<sup>-1</sup>, respectively (&compared to TEXC, \$ compared to REST; both p<0.03, #MOD compared to HIIT; p<0.05), 1229(129)& and 1016(204)&, \$ # dyn s cm<sup>5</sup> (&compared to TEXC; p<0.03, \$compared to REST; p<0.05, #MOD compared to HIIT; p<0.05). PEXC60 MAP, CO and SVR values following MOD and HIIT were 81(6)&, \$ and 81(4)&, \$ mmHg, respectively (&compared to TEXC, \$compared to REST; both p<0.03), 5.2(1.5)& and 5.8(1.5)& L min<sup>-1</sup>, respectively (&compared to TEXC; p<0.03), 1340(78)& and 1151(226)& dyn s cm<sup>5</sup> (&compared to TEXC; p<0.03). **Discussion** Following MOD and HIIT, MAP at PEXC30 was similar to REST, but 5% lower at PEXC60 compared to REST, thus the MAP response is somewhat delayed following termination of exercise. MAP is the product of CO and SVR, and following HIIT, CO was higher, while SVR was lower compared to MOD at PEXC30, hence the initial hemodynamic recovery responses are different following HIIT and MOD. At PEXC60, there was no difference between MOD and HIIT responses, meaning that there is no added effect of HIIT on the PEH response within the short timeframe investigated in the present study. **References** Borjesson M (2008). 327-342. *Aktivitetshandboken*, Oslo.

## DIFFERENCES IN QUALITY OF LIFE BETWEEN ELDERLY RESIDENTS OF RURAL AND URBAN AREAS

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**Introduction** Demographic data on accelerated aging shows that age and disease that follows became not only health, but also socio-economic problem. This fact increases the need for research in this area. The aim of the study was to determine the differences in quality of life between elderly residents of rural and urban areas in terms of form of physical activity. **Methods** Our research survey was conducted on a sample of 102 elderly subjects aged from 60 to 80 years, residents of urban area, and 105 rural subjects of the same age. As a measuring instrument used is standardized survey EQ5D questionnaire on health, as well as a set of questions about the physical exercise. Chi-square test is used for statistical nonparametric analysis. **Results** There was a statistically significant difference in quality of life between elderly residents of rural and urban areas in each of the observed parameters (p<0.05). The results of our study further proof initial hypotheses about the usefulness of physical exercise in various forms of implementation for almost all the observed parameters in both urban and rural sample. **Conclusion** There is a statistically significant difference in quality of life between elderly people who lives in urban and rural areas. Physical activity is important aspect of quality of life in elderly population. **Keywords:** eq5d surveys, physical activity, elderly people, rural and urban area. **References** Spirduso WW, Cronin DL. (2001). *Medicine and Science in Sports and Exercise*, 33(6; Suppl), 598-608. Simonsick EM, Lafferty ME, Phillips CL, Mendes de Leon C, Kasl SV, Seeman TE. (1993). *American Journal of Public Health*, 83(10), 1443-50. Sui X, LaMonte MJ, Laditka JN, Hardin JW, Chase N, Hooker SP. (2007). *JAMA: the journal of the American Medical Association*, 298(21), 2507-16. Wendel-Vos G, Schuit A, Feskens E, Boshuizen H, Verschuren W, Saris W. (2004). *International Journal of Epidemiology*, 33(4), 787-98. Živković M, Šternić N. (2000). *Ishemična bolest mozga. Zavod za udžbenike i nastavna sredstva*, Beograd. Contact Danijela Zivkovic Faculty of Sports and Physical Education, University of Niš, Serbia E-mail: danijela21581@yahoo.com

## EFFECTS OF 12 WEEKS EXERCISE ON PERIPHERAL BDNF, FGF AND IGF-1 IN OBESE ADOLESCENTS

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Exercise has been reported to improve cognitive function in humans and rodents, possibly via BDNF (brain-derived neurotrophic factor), FGF (Fibroblast growth factor) and IGF-1 (insulin-like growth factor-1)-regulated mechanism. The purpose of this study was to investigate the effects of exercise on body composition, blood lipids, BDNF, FGF and IGF-1 in obese adolescents. The subjects of this study were 16 boys, who were divided into exercise group (EG, n=8), control group (CG, n=8). The exercise is a combined exercise that includes walking and resistance training. And the exercise program conducted 50-60 minutes per day, four times a week, for 12-week. The results of comparative analysis are as follows. The comparison of means difference before and after intervention between group, weight (p<.05), BMI (p<.05), Glucose (p<.05) of EG were more significant decreased than CG. And BDNF (p<.05) was more significant increased than CG. Fat percentage, Muscle percentage, TC, TG, HDL-C, LDL-C, FGF and IGF-1 were not different between EG and CG. But fat percentage and LDL-C of EG were more decreased than CG. FGF and IGF-1 of EG was more increased than CG. These data indicate that 12 weeks exercise decreased BMI and increased concentrations of BDNF in the serum, suggesting a possible functional role for this neurotrophic factor in exercise-induced cognitive enhancement in humans.

## APPLICABILITY OF ANTHROPOMETRIC MEASURES FOR ESTIMATING WHOLE-BODY SKELETAL MUSCLE VOLUME IN CHILDREN

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**Introduction** For children, skeletal muscle volume (SMV) reflects nutritional status and its growth-related changes associates with the development of muscular and motor fitness (Fukunaga et al, 1989). At present, magnetic resonance imaging (MRI) is regarded as the

gold standard for measuring SMV. However, this method is costly and time consuming for analysis. It is difficult to use MRI in field work aimed to investigate SMV in a large number of subjects. Thus, the purpose of the present study was to elucidate the applicability of anthropometric measures for estimating SMV in children. Methods One hundred and twenty-seven healthy Japanese children (74 boys and 53 girls, mean age 9.6yr) voluntarily participated in this study. Contiguous MRI images with a 1-cm slice thickness were obtained from the first cervical vertebra to the lateral malleoli. The whole body SMV was calculated by summing up the digitized muscle cross-sectional areas and by multiplying it by the slice thickness. Ten anthropometric measures (circumferences of upper arm, forearm, thigh, lower leg, waist, and hip, waist-to-height ratio, waist-to-hip ratio, weight-to-waist ratio, and weight-to-hip ratio) were adopted to examine their associations with the whole body SMV measured by MRI (MRI-SMV). Results & Discussion The MRI-SMV was  $8742.2 \pm 2551.2$  cm<sup>3</sup> for boys and  $8798.7 \pm 288.2$  cm<sup>3</sup> for girls. All anthropometric parameters except waist-to-height and waist-to-hip ratios were significantly correlated to MRI-SMV ( $r = 0.62 - 0.91$ ,  $p < 0.005$ ). Among these parameters, weight-to-waist ratio was the best predictor of MRI-SMV ( $R^2 = 0.825$  and  $SEE = 856.2$  cm<sup>3</sup> [9.8%]). The SMV values estimated from the regression equation with the weight-to-waist ratio as an independent variable ( $y = 24536.3x - 4911.0$ ) did not significantly differ from MRI-SMV. Bland-Altman plot showed that the residual had no systematic error which depends on the magnitude of SMV. Weight-to-waist ratio can be considered as an index of the whole body density, because waist is a convenient measure estimating fat mass (Mehdad et al. 2012; Daniels et al. 2000). This may be a reason for the strong association between weight-to-waist ratio and MRI-SMV. Conclusion Anthropometric measures, especially weight-to-waist ratio, are useful for estimating the whole-body SMV in Japanese children. References Fukunaga et al. (1989). *J Anthropol Soc Nippon*. 97:61-2. Mehdad et al. (2012). *J Nutr Metab*. 57:35-9. Daniels et al. (2000). *Am J Epidemiol*. 152:1179-84. Contact Megumi Ohta [m-ohata@lets.chukyo-u.ac.jp]

### FITNESS TESTS TO PREDICT FUNCTIONALITY IN OLDER ADULTS WITH AMNESTIC MILD COGNITIVE IMPAIRMENT

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Introduction Amnesic Mild Cognitive Impairment (a-MCI) is usually considered a previous stage for Alzheimer's disease (Petersen, 2004). Functionality is a key component of quality of life and risk of frailty in older adults. The aim of this study was to explore the baseline correlations and power of prediction of different fitness tests with functionality measurements in this population. Methods Forty-one people diagnosed by trained neurologists with Amnesic Mild Cognitive Impairment, according to Petersen (2004) criteria, were recruited from the Neurology Unit of the Hospital de San Vicente del Raspeig (Spain). Fitness tests included the 6 minute walk test (6MWT), the 8-meter walk test (speed of gait), the timed get up and go test (TGUG), and the Chair-Stand test (CST). The Disability Assessment for Dementia (DAD) and the Functionality Assessment Questionnaire (FAQ), were used to measure functionality. Partial correlations and a stepwise linear regression model were used in order to explore baseline associations between fitness tests and functionality measurements. Results Partial correlations controlling for age, gender and education, showed that a better performance in the TGUG strongly correlated with better functionality as measured in both the the DAD ( $p < 0.001$ ), and the FAQ ( $p < 0.001$ ). The 6MWT showed a positive tendency with functionality. Speed of gait and the Chair Stand Test did not correlate with either the DAD or the FAQ. When the regression model was applied, the TGUG remained as a predictive variable for the DAD ( $p < 0.001$ ) and the FAQ ( $p < 0.001$ ). Discussion People with Mild Cognitive Impairment start to experience a decrease in functionality that causes difficulties in activities of daily living (Brown et al. 2011). In our study, the fitness test that best correlated with functionality was the TGUG test. A better performance on this test has been also associated with a reduced risk of falling (Shumway-Cook et al., 2000) and with improved executive function and memory (Donoghue et al., 2012) in older adults. Considering the reduced time and cost of using this test, it should be considered by clinicians as a tool for assessing functionality in older adults with Mild Cognitive Impairment. References Brown P J, Devanand DP, Liu X, Caccappolo E (2011). *Arch Gen Psych*, 68, 617-626. Donoghue OA, Horgan NF, Sawwa GM, et al. (2012). *J Am Geriatr Soc*, 60:1681-6. Shumway-Cook A, Brauer S, Woollacott M (2000). *Phys Ther*, 80:896-903. Petersen RC (2004). *J Int Med*, 256(3), 183-324. Contact juan.tortosa@ua.es

### RELATIONSHIPS BETWEEN PARENTAL AWARENESS OF PHYSICAL ACTIVITY DURING THEIR CHILD'S EARLY CHILDHOOD AND MOTOR SKILLS IN LATER CHILDHOOD

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AIM: This study examined relationships between parental awareness of physical activity during early childhood, motor skills and activities of daily living in later childhood. METHOD: Participants were 108 children (55 boys, 53 girls; age from 6y to 11y). we collected the results of elementary-school children motor skills tests and ran a questionnaire for boys, girls, and their parents. RESULTS: The sons of parents who answered that 'they tried to get their children to engage in physical activity in early childhood' had higher motor skills throughout the six-years of elementary school. In addition, the sons of parents who answered they tried to get their children to engage in physical activity in early childhood liked physical exercise and were more likely to play outside after returning home from school. This results showed that parental awareness during their child's early childhood possibly has an effect on the child's motor skills, level of physical activity and enjoyment of exercise in later childhood. However, no significant relationship between parental awareness and child motor skills was observed in girls. The reason was that girls overall are less motivated to exercise and are more likely to play indoors after returning home from school. Furthermore, no relationship between the later-childhood motor skills and number of years using a stroller during infancy and means of going to kindergarten was observed.

### WOMEN HEALTH-RELATED FITNESS PARTICIPANTS' PERCEIVED AUTONOMY SUPPORT AND BASIC PSYCHOLOGICAL NEEDS IN TERMS OF EXERCISE STAGES OF CHANGE

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Introduction Nowadays physical activity paradigm has been focused on health-related concept for promoting the healthy lifestyle. It is claimed that motivational climate might be influential on sport participants' engagement and satisfaction of their basic psychological needs like autonomy, competence and relatedness (Duda, 2001). Using self-determination theory (Deci, & Ryan, 2008) as an effective concept in human behavior, the aim of this study was to examine the women health-related physical activity participants' perceived autonomy support and basic psychological needs in exercise setting in terms of their exercise stages of change (five stages including pre-contemplation, contemplation, preparation, action and maintenance) at a university setting. Methods The sample consisted of 175

women (M age= 25.1, SD= 7.2) participating in health-related physical activity program in a university setting. Participants completed the Perceived Autonomy Support (Hagger et al., 2007), Basic Psychological Needs in Exercise Setting (Vlachopoulos, & Michailidou, 2006) and Exercise Stages of Change (Prochaska & DiClemente 1983) questionnaires. Data analyzed by using one-way ANOVA and one-way MANOVA ( $p < .05$ ). Results Findings indicated that perceived autonomy support was significantly different by exercise stages of change ( $p < .05$ ). Further analysis indicated that only the participants in the action stage had higher perceived autonomy support from the participants in the contemplation stage. Findings on basic psychological needs in exercise revealed that there was no significant difference between basic psychological needs in exercise and exercise stages of change ( $p > .05$ ). Discussion To meet the needs of women health-related physical activity participants, health-related physical activity program instructors should pay more attention to provide an autonomy supportive climate by the needs of each participants' exercise stages of change. References Duda, J. L. (2001). Goal perspectives and their implications for health related outcomes in the physical domain. *Advances in motivation theories in the sport domain*. Paris: Presses Universitaires de France. Deci, E. L., & Ryan, R. M. (2008). Self-determination theory: A macro theory of human motivation, development, and health. *Canadian Psychology*, 49(3), 182. Hagger, M. S., Chatzisarantis, N. L., Hein, V., Pihu, M., Soós, I., & Karsai, I. (2007). The perceived autonomy support scale for exercise settings: Development, validity, and cross-cultural invariance in young people. *Psychology of Sport and Exercise*, 8(5), 632-653. Prochaska, J.O., Marcus, B.H. (1994). The trans-theoretical model: Applications to exercise. In R.K. Dishman (Ed.), *Advances in exercise adherence* (pp. 161-180). Champaign, IL: Human Kinetics. Vlachopoulos, S. P., & Michailidou, S. (2006). Development and initial validation of a measure of autonomy, competence, and relatedness in exercise: The Basic Psychological Needs in Exercise Scale. *Measurement in Physical Education and Exercise Science*, 10(3), 179-201.

## PREDISPOSITION TO PHYSICAL ACTIVITY IN FIREFIGHTERS OF LOMBARDY

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**Introduction** The purpose of this preliminary survey was to explore the predispositions to physical activity (PA) in firefighters (F) from Lombardy (a region in the north of Italy), through the observation and analysis of their motor habits, both in service and out, linked with their socio-anagraphic characteristics and their BMI (Body Mass Index). Depending on the results obtained from the survey is proposed a plan of general actions to prevent injuries and protect F's health. **Methods** The survey was conducted on a sample of 1328 F from 11 Commands of Lombardy through a descriptive questionnaire on PA (Vivian, A., 2013). F were classified according to BMI into four categories: underweight (BMI<18.5), normal weight (18.5≤BMI≤24.9), overweight (25≤BMI≤29.9), and obese (BMI≥30), and compared in relation to PA and socio-demographic variables considered. Statistical differences between groups were identified through SPSS statistical programme. Results F were almost all male (99,8%), aged 39,2±8,7; 54.6% results being normal-weight, 38.9% overweight; 6.5% obese. No underweight was found. A chi square statistic is used to investigate the answer of different categories. The number of normal-weight subjects decreases significantly with age ( $p < 0.05$ ). PA on duty is practiced regularly by only 14.6% of normal weight, by 8.7% of overweight and 4.7% obese ( $p < 0.05$ ). PA outside the workplace is regularly done only by 62.5% normal weight subjects; 50.5% of overweight and 50% of obese subjects does just occasionally exercise. F who always practise PA (n=155) has an high educational level. F who don't have children appear to be less overweight ( $p < 0.05$ ). **Discussion** F of Lombardy don't take part regularly in PA, both off and especially in duty. This gives them a harder time in particularly demanding interventions. A gradual lack of interest towards PA seems to be related to the increasing of age. Other factors which influence PA are the level of education, the presence of children, the family status, personal issues, such as the very little interest in exercise and barriers as the availability of spaces and equipment. All these aspects could be overcome through a movement education addressed to everyone, to the personnel with its family and to those holding a major role. In support of importance of PA in duty, the collected data show that, who follows that habits, has a more balanced BMI and perceive less fatigue during critical interventions. References Perroni F, Cignitti L, Cortis C, Capranica L. (2014). *Appl. Ergon*, 45 (3), 456-61. Storer TW, Dolezal BA, Abrazado ML, Smith DL, Batalin MA, Tseng CH, Cooper CB. (2014). *J Strength Cond Res*. 28(3), 661-671 Vivian, A. (2013). experimental project of the Master of II° level in 'Sport e intervento psicosociale' by "Alta Scuola di Psicologia" of the Università Cattolica del Sacro Cuore of Milan. Contacts [ferdinando.cereda@unicatt.it](mailto:ferdinando.cereda@unicatt.it)

## SLEEP TIME MEASURED BY ACTIGRAPHY IN OLDER ADULTS: A BRIEF REVIEW

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**INTRODUCTION** Older adults' (OA) current lifestyles produce imbalances in their circadian cycles, which are influenced by aging and particular factors that impede getting out of home (1). Inappropriate and irregular sleep time (ST) cause serious diseases, especially in this population (2). Actigraphy has become an essential tool in sleep research (3) but there is still a gap related to its reliability and efficacy among the elderly, mainly in the last stage of life, when individuals are mostly sedentary. This brief review aims to deep in the use of accelerometers in the assessment of ST in OA, remarking some particularities. **METHODS** Electronic searches for ST studies in OA were performed in SCOPUS, PUBMED, MEDLINE, EBSCO, WEB OF SCIENCE and GOOGLE SCHOLAR until January 2015. Inclusion criteria were: 55+ years of age, published from 2013 and measured with actigraphy. Relevant studies were graded according to the Oxford Levels of Evidence. **RESULTS** We screened 3990 search results. After careful reviewing, only 10 studies have met the inclusion criteria for this review. They focus on sleep activity patterns, ST quality, insomnia, total ST, sleep efficiency, wake after sleep onset, sleep-wake cycles, sleep initiation, periodic leg and body movements and evening light. Authors point out the relationship between actigraphy and quality of life, depression, dementia, obesity, EPOC, diabetes and cardiovascular diseases, among others (4). 50% of the studies used wrist actigraphy, 20% waist, 10% PAM-LR devices, 10% were review manuscripts, and the remaining 10.3% did not specify the device employed. **DISCUSSION** Evidence from studies reviewed suggests the adequacy of actigraphy to measure ST patterns in OA as well as the effectivity in documenting the effects of various behavioural and medical factors related with sleep-wake cycles in this population. Likewise, accelerometers are devices of small size, relatively cheap and easy to use. However, several problems have been detected in their implementation with OA: small samples, necessity of increasing the validation of these particular devices, more feasible algorithms and low usefulness in patients with cognitive disorders, insomnia or respiratory illness. Further studies are required in order to improve and verify the suitability of actigraphy on measuring ST in OA; mainly among chronically ill and sedentary OA subpopulations. **REFERENCES** 1. Obayashi K, Saeki K, Iwamoto J, Okamoto N, Tomioka K, Nezu S, et al.(2014). *Chronobiol Int*. 31(4), 461-7. 2. Kay DB, Buysse DJ, Germain A, Hall M, Monk TH (2015). *J Sleep Res* 24(1), 32-9. 3. Sade, A, Acebo, C (2002). *Sleep Med Rev* 6(2), 113-124. 4. Anderson KN, Catt M, Collerton J, Davies K, Von Zglinicki T, Kirkwood TBL, et al. (2014). *Age Ageing* 43(1), 57-63.

## EVALUATION OF RISK FACTORS ASSOCIATED WITH EXERCISE-INDUCED BRONCHOSPASM IN ADOLESCENTS

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## PHYSICAL ACTIVITY BEFORE AND DURING PREGNANCY IN HUNGARY

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Introduction The advantages of regular physical activity during pregnancy are improved emotional well-being, reduced risk of gestational diabetes mellitus (Dempsey et al., 2004), and excess maternal weight gain (Clapp & Little, 1995). Currently, little is known about the physical activity patterns of pregnant women in Hungary. The aim of this study was to analyse the lifestyle of pregnant women with a special attention on their physical activity before and during pregnancy. Methods The self-administered questionnaire-based study was conducted among women who had given birth to their babies at the Department of Obstetrics and Gynecology, University of Szeged. The mothers were interviewed one or two days after the delivery. It is an ongoing study, data collected in the first six months of 2014 were involved into the preliminary evaluation ( $n = 660$ ). The study protocol was approved by the Research Ethics Committee of the University of Szeged. Results The mean age of the participants was 31.76 years. Prior to their pregnancy, 50.7% of women were engaged in some kind of physical activity (swimming, running, and cycling). The frequency of exercise was quite variable: 3.4% of women exercised at least once a week, whereas 44.6% of them exercised once a day. The duration of the physical activity per occasion was also different: 33.9% of women preferred a 60 minutes-long workout session. 15.1% of women did competitive sport, but most of them discontinued the competitive exercise after the detection of pregnancy, so during pregnancy only 6.5% of women did some kind of sport, although more than 50% of women were physically active, and walking was the most preferred form of exercise during pregnancy. Only 8.8% of all women attended pregnancy gymnastic classes. Discussion Our results are in accordance with the literature (Domingues & Barros, 2007), such as the prevalence of physical activity is low among Hungarian pregnant women, and walking is the most frequent activity. The improvement of the healthy way of life at population level, and especially during pregnancy plays significant role in the prevention of later chronic diseases, so young women have to be educated about the importance of active lifestyle in women of childbearing age. References: Clapp JF, Little KD (1995). *Med Sci Sports Exerc*, 27:170-177. Dempsey JC, Butler CL, Sorensen TK, Lee I-M, Thompson ML, Miller RS, et al (2004). *Diabetes Res Clin Pract*, 66:203-215. Domingues MR, Barros AJD (2007). *Rev Saúde Pública* 41(2):173-180. Contact: barkaniki@gmail.com

## CHANGES AFTER AN 8-MONTHS SCHOOL-BASED PHYSICAL ACTIVITY INTERVENTION PROGRAM FOR OBESE CHILDREN AND ADOLESCENTS

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Introduction: Programs to prevent and control weight-related problems are needed and should be implemented in early ages. The aim of the present study was to evaluate the changes in several health indicators after an 8-months school-based physical activity (PA) intervention program. Methods: 56 overweight and obese children and adolescents (25 control e 31 intervention) from 7 to 16 year-olds (31 girls) of 6 public schools in Porto participated in an 8-months school-based physical activity intervention program, consisted of 3 hours of Physical Education and 2 hours of after-school exercise sessions (five hours per week). Physical exercise sessions were designed to develop aerobic endurance, strength, flexibility, coordination and balance, through games with balls, bows, strings, callisthenic exercises and strength training. The exercise program was also designed to develop the enjoyment and body awareness looking to long-term changes in behavioural patterns. Anthropometry, blood pressure, blood samples (lipid profile, apolipoproteins, vitamin D, insulin, glucose, liver enzymes), PA and sedentary behaviour (accelerometry), cardiorespiratory fitness (ergospirometry), and body composition (DXA), were taken before and after the intervention. Changes between baseline and post-intervention data were calculated by paired samples t-test in SPSS (version 20.0), and level of significance was set up at 95%. Results: When comparing intervention and control groups, significant positive changes were observed for bone density, lean mass, cardiorespiratory fitness, moderate-to-vigorous PA, light PA, and sedentary behaviours. For the intervention group, baseline and post intervention results showed significant positive changes for bone density, moderate-to-vigorous PA, sedentary behaviours, apolipoproteins, liver enzymes, lipid profile and glucose. Conclusion:

An 8-months school-based physical activity intervention program promoted significant positive changes in several health indicators. Contact: clarice.br@fade.up.pt

### AGE AND GENDER-RELATED DIFFERENCES IN FUNCTIONAL FITNESS AMONG COMMUNITY-DWELLING OLDER ADULTS IN TAIWAN

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**Introduction:** Population is growing old rapidly in Taiwan, the proportion of people older than 65 is projected to be 14% in 2017, and up to 20% in 2025. The combined effects of aging process, disease, and sedentary life style tend to reduce functional fitness and result in difficulties in daily life activities and normal functioning of the elderly. This cross-sectional study aimed to explore the age and gender-related differences in functional fitness among a group of community-dwelling older adults in Taiwan, and further to compare their fitness level with that of published criterion fitness standards in other countries. **Methods:** Older adults aged 65+ from six community senior-care stations of Hsinchu city, Taiwan were recruited to participate in a 12-week community-based physical activity (PA) intervention program. Functional fitness was assessed using the Senior Fitness Test to evaluate the effects of the intervention program. The measurement items included: body height, body weight, body mass index (BMI), waist circumference, 30-sec arm curl, 30-sec chair stand, back scratch, chair sit & reach, 8-ft up & go, and 2-min step. The subjects' functional fitness performance at baseline was presented here to explore the age and gender-associated patterns. Data analyses were conducted by using SPSS version 19.0 for Windows. Significance was set at 0.05. **Results:** A total of 138 senior adults were recruited with predominantly female (89%). Their mean age was 77.2±6.3 years, mean body height 152.4±6.7cm, and mean body weight 57.4±9.1Kg; mean BMI 24.7±3.5 with 45% were overweight or obese and 62% with central obesity. Significant age-related declines were found for 30-sec arm curl, 30-sec chair stand, chair sit & reach, 8-ft up & go, and 2-min step across 6 age subgroups (65-69, 70-74, 75-79, 80-84, 85-89, and 90+) with sharp decline around 80 years. Female showed better flexibility than male subjects. When comparing their fitness level with that of published criterion fitness standards, the overall functional fitness performance of our study subjects were graded approximately at "poor" level. **Discussions:** The functional fitness of community-dwelling senior adults decreased significantly with age with sharp decline around 80 years. Regular PA was shown to slow the rate of decline in both aerobic and musculoskeletal systems and hence improve functional capacity. It is expected to see whether participation in a group-based or pedometer-assisted PA intervention program may positively affect community-dwelling older adults' PA level, functional fitness, and health-related quality of life while reversing frailty status. **References:** 1.Adamo DE, Talley SA, Goldberg A. Age and task differences in functional fitness in older women: comparisons with Senior Fitness Test normative and criterion-referenced data. *J Aging Phys Act.* 2015;23(1):47-54. 2.Milanovic Z, Pantelic S, Trajkovic N, Sporis G, Kostic R, James N. Age-related decrease in physical activity and functional fitness among elderly men and women. *Clin Interv Aging.* 2013;8:549-56.

### EFFECTS OF INTERVAL TRAINING VERSUS CONTINUOUS TRAINING IN MODERATELY OBESE WOMEN: A PILOT STUDY

Garnier, S., Idiart, A., Laffargue, P., Liu, L., Candebat, R., Joanisse, D.R., Joffroy, J., Mauriège, P.

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**Introduction** Epidemiological evidence supports the notion that both sedentarity and obesity are associated with numerous risk factors for all causes of mortality and premature death, and more particularly, coronary heart disease in women (Mora et al., 2006, Mosca et al., 2007). Although high-intensity intermittent exercise was suggested to reduce body weight and fat mass in overweight individuals, more studies are clearly needed (Boutcher, 2011). The main objective of this study is to compare the effects of interval training, IT vs continuous training, CT on weight loss, cardiorespiratory fitness (CRF), perceived health, quality of life (QoL) and eating behaviors. **Methods** 49 voluntary, healthy, sedentary and moderately obese (mean body mass index, BMI = 32 ± 4 kg/m<sup>2</sup>) women (37.5 ± 9.5 years old), were randomized to IT (24) or CT (25) group. The two groups performed exercise 3 times a week, during 12 weeks. Each session of interval training gradually increased from 6 to 10 X 1-min cycling at 75 to 85 % of heart rate reserve (HRR), and continuous training gradually increased from 20 to 35 min cycling at 50 to 60% HRR. Following measurements were obtained from 10 and 13 women respectively subjected to IT and CT, before and after 12 weeks: CRF assessed by the 2-km walking test and estimated VO<sub>2</sub>max calculated (Laukkanen et al., 1993), height, weight (BMI calculated) and waist circumference measured using standardized procedures, fat mass and fat-free mass determined by bioelectrical impedance, perceived health estimated by the short perceived health questionnaire (SPHQ; Garnier et al. 2013), QoL estimated by SF-36 (Ware and Gandek, 1998), eating behaviors estimated by the three-factor eating questionnaire (TFEQ) (Stunkard et al., 1985). **Results** Estimated VO<sub>2</sub>max remained unchanged while BMI, waist girth and fat mass decreased in the two groups (p<.01). The physical component of QoL (SF-36) (p<.01), cognitive restraint and hunger (TFEQ) as well as the six items of perceived health (SPHQ) increased in the two groups (p<.05). **Discussion** Results of this randomized pilot study performed in healthy, sedentary and moderately obese women showed that the 12-weeks interval training or continuous training program led to similar improvements in CRF and perceived health, and body weight and fat mass losses. **References** Boutcher SH. (2011). *J Obes*, 2011: ID868305 Garnier S, et al. (2013). *Menopause*, 20(8): 804-812. Laukkanen R, et al. (1992). *Int J Obes Relat Metab Disord*, 16: 263-268. Mora S, et al. (2006). *JAMA*, 295: 1412-1419. Mosca L, et al. (2007). *J Am Coll Cardiol*, 49(11): 1230-1250. Ware JE, Gandek B. (1998). *J Clin Epidemiol*, 51: 903-912. Stunkard AJ, Messick S. (1985). *J Psychosom Res*, 29: 71-83. Contact sophie.garnier@wanadoo.fr

### AEROBIC CAPACITY AND TEST OF VARIABLES OF ATTENTION PERFORMANCE IN ELEMENTARY SCHOOL-AGE CHILDREN

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**Introduction** The impact of aerobic fitness on childhood cognitive and brain health has only recently gained attention. Aerobic fitness has been shown positive association multiple aspects of cognitive control (Scudder, Lambourne, Drollette, Herrmann, Washburn, Donnelly, Hillman, 2014). The Test of Variables of Attention (TOVA) is a continuous performance test (CPT) that assesses attention, impulsivity, and processing speed. CPTs are used in the assessment of attention-deficit/hyperactivity disorder (ADHD) in children and adults (Greenberg, Kindschi, Dupuy, & Corman, 1996). The TOVA norms are based on a standardization sample that was tested early in the day, and any TOVA administered after 1:00 p.m. will be flagged as potentially invalid (Hunt, Momjian, Wong, 2011). The purpose of current study was to examine the relationship between children's performance on the Progressive Aerobic Cardiovascular Endurance Run (PACER) subtest of



the FitnessGram® and aspects of continuous performance test that are believed to support academic success. Methods Twenty-three healthy female of second-grade (age  $7.87 \pm 0.08$  years, weight= $25.14 \pm 0.72$  kg; height= $127.38 \pm 1.05$  cm, BMI= $15.47 \pm 0.37$  kg/m<sup>2</sup>) from community attended the PACER tests and TOVA on weekend morning. Pearson correlation was conducted on the distance of PACER tests and indices of TOVA. Results Greater aerobic fitness was significantly related to fewer omission (inattention) errors ( $r = -.437$ ,  $p = .037$ ) and shorter reaction time ( $r = -.433$ ,  $p = .039$ ), but relationship to commission (impulsivity) errors was not found. Discussion The human brain is not fully developed until the third decade of life; Maintaining aerobic fitness in childhood may be a critical guideline to follow for physical as well as cognitive and brain health (Khan & Hillman, 2014). Children with a history of grade retention had significantly lower scores on the same measure of sustained attention (Gordon, Mettelman, Irwin, 1994). Cardiorespiratory fitness was related to academic achievement (Sardinha, Marques, Martins, Palmeira, Minderico, 2014). The findings suggesting better sustained attention in higher-fit children that are believed to support academic success. Supported by MOST Grant 103-2410-H-320-010 References Scudder MR, Lambourne K, Drollette ES, Herrmann SD, Washburn RA, Donnelly JE, Hillman CH. (2014). *Med Sci Sports Exerc.* 46(5):1025-35. Khan NA, & Hillman CH. (2014). *Pediatr Exerc Sci.* 26(2):138-46. Gordon M, Mettelman BB, Irwin M. (1994). *Percept Mot Skills.* 78(2):555-60. Greenberg LM, Kindschi T, Dupuy TR, & Corman C. (1996). Los Alamitos, CA: Universal Attention Disorders. Sardinha LB, Marques A, Martins S, Palmeira A, Minderico C. (2014). *BMC Pediatr.* 14:176. Hunt MG, Momjian AJ, Wong KK. (2011). *Psychol Assess.* 23(1):226-33.

### ASSOCIATIONS BETWEEN PERMANENCE TIME IN A PHYSICAL ACTIVITY PROGRAM CARRIED OUT IN PRIMARY HEALTH CARE AND FUNCTIONAL FITNESS IN BRAZILIAN ADULTS

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Introduction World Health Organization, the Centers for Disease Control and Prevention, and the ACSM have been working together with Universities worldwide to determine which physical activity intervention can be more effective and efficient to promote healthy lifestyles (Pratt et al, 2010). According to Gomes et al (2014), 39.5% of the Primary Health Care Unit (PHCU) in Brazil offer physical activity program. However, these programs did not show the influence of the permanence time in the program with functional fitness. Thus, the aim of this study was verify the association between permanence time in a program carried out in the PHCU and functional variables in Brazilians adults. Methods This study evaluated 45 ( $53.5 \pm 11.4$  years of age) participants of the "Programa de exercício físico em unidades de saúde" in Rio Claro-SP, Brazil. The program offers sessions of moderate general exercise. The permanence time was calculated using percentual of class ministred with class frequency during six-months. The functional fitness was evaluated thought AAHPERD test. The simple linear regression test was used to verify associations between functional fitness and permanence time using STATA 12.0. Results The range of frequency was 22.2% and 96.4% respectively. The coordination variable showed positive association with the frequency in program (coef=0.7;  $p < 0.05$ ). The strength, agility, flexibility and aerobic capacity variable were not significantly associated with permanence time ( $p > 0.05$ ). Discussion According Nakamura et al. (2007) program with more session frequency is better to improve functional fitness. This result showed that more physical exercise people, more they improve the coordination. In PHCU this kind of exercise program is an important strategy to improve functional fitness. However, others studies are necessary to understand the role among frequency in the class with improve in variable relation with functional fitness. Reference Pratt M, Brownson RC, Ramos LR, Malta DC, Hallal PC, Reis RS, Parra DC, Simões EJ. Design Guide: a model for understanding and promoting PA in Brazil and Latin America. *JPAH.* 2010; 7: S131-S134. Gomes, G.A.O; KokubunE; Mieke, G.I et al. Characteristics of physical activity programs in the Brazilian primary health care system. *Cad. Saúde Pública [online].* 2014, vol.30, n.10, pp. 2155-2168. ISSN 0102-311X. <http://dx.doi.org/10.1590/0102-311X00085713>. Nakamura, Y; Tanaka, K; Yabushita, N; Sakai, T; Shigematsu. Effects of exercise frequency on functional fitness in older adult women. *Archives of gerontology and geriatrics.* 2007, vol.44, p.163-173. Contact leocampos\_89@hotmail.com CNPq processo 156965/2014-3.

### HIGH CARDIORESPIRATORY FITNESS ATTENUATES CAROTID ARTERIAL STIFFENING IN MEN WITH THE METABOLIC SYNDROME

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Introduction Carotid arterial stiffness is associated with an increased risk of stroke and cardiovascular disease. Even, metabolic syndrome (MetS) is associated with increased carotid artery stiffness (Czernichow et al., 2005). On the other hand, high cardiorespiratory fitness (CRF) is associated with slower progression of early atherosclerosis in men. However, the associated between CRF and carotid arterial stiffness in men with MetS is under established. Thus, the purpose of this study was to test hypothesis that high cardiorespiratory fitness attenuates carotid arterial stiffening in men with the Mets. Methods The study participants were 536 Korean men (19 - 64 yrs) from the first year of the Korea National Fitness Award Project. The CRF was quantified from the duration of a maximal treadmill exercise test. Based on cut-off point associated with MetS for Korean men (Park, 2014, in submission), participants were divided by high and low fit. Carotid artery intima-media thickness (IMT) and stiffness parameters were measured on ultrasound image using e-tracking. And, brachial ankle pulse wave velocity (baPWV) was measured. Results In logistic regression analysis, a dose-response relationship was observed between increased levels of CRF and decreased prevalence of MetS in Korean men (high fitness: OR=0.342, 95%CI 0.182-0.644). The risk was 39% lower for the increase by 1 METs (OR=0.614, 95% CI 0.486-0.775) in multivariate adjusted model. There was no difference in carotid arterial stiffness indices between fit men with and without the MetS. However, high-fit men with the MetS had significantly lower cIMT (MetS/low-fit  $0.59 \pm 0.14$  mm vs. MetS/fit  $0.54 \pm 0.09$  mm vs. Healthy/low-fit  $0.59 \pm 0.13$  mm vs. Healthy/fit  $0.51 \pm 0.1$  mm,  $p = 0.002$ ),  $\beta$  (MetS/low-fit  $8.53 \pm 3.52$  (arbitrary units) vs. MetS/fit  $5.83 \pm 1.53$  vs. Healthy/low-fit  $7.53 \pm 2.98$  vs. Healthy/fit  $6.38 \pm 2.48$ ,  $p = 0.016$ ) and baPWV (MetS/low-fit  $1434 \pm 237$  cm/s vs. MetS/fit  $1279 \pm 118$  cm/s vs. Healthy/low-fit  $1327 \pm 191$  cm/s vs. Healthy/fit  $1251 \pm 170$  cm/s,  $p < 0.001$ ) than both low-fit men with the MetS and even without the MetS. Discussion The major finding of this study was that high CRF attenuated carotid arterial stiffness in men with and without the MetS. Furthermore, high CRF men with the MetS showed the attenuation of carotid arterial stiffness compared to low CRF men with and without the MetS. There are limitations that need to be highlighted. First, given the cross-sectional nature of this study, we were not able to determine causality. Second, these results may not be generalized to women. The study results suggest that high CRF may be a strong protective effect of cerebro-cardiovascular disease in men with the MetS. Reference Park S. et al., 2014 in submission. Czernichow S, Bertrais S, Blacher J, Oppert JM, Galan P, Ducimetière P, Hercberg S, Safar M, Zureik M. (2005). *Am J Hypertens.* 18(9 Pt 1):1154-60.

## BODY COMPOSITION, PHYSICAL ACTIVITY AND DIETARY INTAKE OF JAPANESE CHILDREN

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**Introduction** Increased number of obesity has recently observed in Japanese children and it has become public health concern. Keep adequate body composition, particularly body fat percentage from childhood is important to prevent lifestyle-related diseases. The purpose of this study was to investigate the differences in physical activity and dietary intake between higher body fat (H-fat) and lower body fat (L-fat) groups in Japanese elementary school children. **Methods** This was a cross-sectional study with sixty-four children, 30 boys and 34 girls aged 10-11 years old, measured height, weight and body fat percentage. Subjects were divided by body fat percentage into two groups, H-fat and L-fat, according to gender. The subjects' physical activity and dietary intake were assessed by wearing accelerometer in a week and using self-reported three-day food records, respectively. **Results** Among boys, average body fat percentage of H-fat was  $22.9 \pm 5.3\%$ , of L-fat was  $9.8 \pm 2.4\%$  and among girls,  $25.1 \pm 5.6\%$  and  $16.4 \pm 3.0\%$  (mean $\pm$ SD) respectively. H-fat in boys had a higher week averaged total energy expenditure ( $p < 0.05$ ) but a lower week maximum counts of steps (steps/day) ( $p < 0.05$ ) and a lower week maximum activity time ( $p < 0.05$ ) than L-fat in boys. H-fat in girls had a higher week averaged total energy expenditure ( $p < 0.05$ ) than L-fat in girls. H-fat in boys consumed a smaller amounts of milk and milk products ( $p < 0.05$ ), and also had a higher energy intake percentage in breakfast ( $p < 0.05$ ) and a lower energy intake percentage in dinner ( $p < 0.05$ ) than L-fat in boys. While, there were no significant differences in dietary intake between H-fat and L-fat among girls. **Discussion/Conclusion** Different body fat percentage groups in Japanese elementary school children had some important trends in physical activity and dietary intake especially in boys. Further studies are needed to develop successful strategies that address physical activity and dietary intake to prevent obesity among Japanese children.

## RESEARCHING THE HEALTH STATUS OF HEALTHCARE PROFESSIONALS WORKING IN AN INSTITUTE FOR CHRONICALLY ILL PSYCHIATRIC PATIENTS

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**Introduction** Several research works in the related international literature on sociology and health sciences deal with the state of health in one selected population. These studies predominantly examine the self-rated subjective health status using questionnaires. In light of that our research is limited to the employees of a certain institute, it can be considered a case study within the scope of qualitative measurement methods. Moreover, our approach was to assess the objective state of health alongside the subjective factors, as our hypothesis was that the majority of the indicators presumably coincided. **Methods** In order to assess the subjective state of health, the individuals had to fill out three functionally different questionnaires. The first one examined the mental well-being based on the answers given to the five questions of the WHO WBI-5 international test and the WHOQOL-BREF26 concerned the interviewees' satisfactions with their quality of life, the third questionnaire containing 56 questions along the background part – that explored the following dimensions: place of employment, working conditions. Regarding the indicators of objective health status, we measured the ratio of height and body components (water, protein, mineral matter and fat), also the fat–muscle ratio, waist–hip ratio, the extent of abdominal obesity and the BMI (Body Mass Index). **Results** The subjective and objective data do not overlap in most cases. The objective results of only 31 people in the 'Fine and satisfied' group were in harmony with the subjective self-rating of health. In the 'Unwell and unsatisfied' cluster only 9 out of 43 people's objective data did not challenge the subjective results. In the 'Fine but unsatisfied' cluster, the objective indicators prevailed to such an extent that there was only one person whose objective and subjective indicators showed the same outcome (Nagyvárad, 2014). **Discussion** As already emphasized in the beginning of our research paper, our hypothesis claims that if we take into account the subjective health indicators along with the objective ones, they would presumably coincide to a big extent. However, based on the findings it is apparent that our hypothesis was not verified. **References** 1. Mavaddat N., Parker R.A. et al. (2014). Relationship of self-rated health with Fatal and Non-Fatal Outcomes in Cardiovascular Disease: A Systematic Review and Meta-Analysis. [www.plosone.org](http://www.plosone.org). letöltve: 2014.09.30. 2. Molarius, A., K. Berglund et al. (2006). Socioeconomic conditions, lifestyle factors, and self-rated health among men and women in Sweden. *European Journal of Public Health*, Vol. 17, No. 2, 125-133. 3. Nagyvárad K. (2014). Életminőség vizsgálat egy krónikus pszichiátriai betegetek gondozó intézmény szakdolgozóinak körében. (PhD disszertáció kézirat) Contact: itaky@mnsk.nyne.hu

## THE EFFECT OF BIKE LANES DISTANCE ON BICYCLE COMMUTING ADOPTION – A LONGITUDINAL STUDY

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**Introduction** Although new bike paths/lanes are often built to promote bicycle use, there are few studies using objective measures to investigate the influence of these structures. In addition, studies which showed association between cycling and bike paths/lanes have typically been conducted in high-income countries and employed cross-sectional designs (Fraser and Lock, 2010). Therefore, the aim of this study was to investigate the effect of bike lanes distance on bicycle commuting adoption in adults. **Methods** Longitudinal study, with a sample of 381 adults non-bikers, living in Rio Claro city - SP – Brazil. The baseline was conducted in 2008 and the follow-up in 2014, after the implementation of 22 bike lanes segments, totalling 18.8 km. The shortest distance between the participant's house and the bike lanes were determined through the Geographic Information System. To evaluate bicycle commuting, a question regarding the frequency and time of use from the International Physical Activity Questionnaire was utilized. Poisson regression was performed, adjusting for age, gender and socioeconomic status. **Results** Among the 381 participants followed, 4.2% started cycling after the bike lanes implementation. Participants living farther than 800 meters from the bike lanes showed lower chances of bicycle commuting adoption (Relative Risk= 0.30; Confidence Interval-95%=0.09-0.95) when compared to those living within 200 meters from the bike lanes. **Discussion** These results reinforce the positive effect of bike lanes implementation on bicycle commuting adoption. In addition, bike lanes implementation should consider the distance between the target population and the bike lane. **References** Fraser SDS, Lock k (2010). Cycling for transport and public health: a systematic review of the effect of the environment on cycling. *European Journal of Public Health*. 21(6), 738-743. Contact [inaianteixeira@hotmail.com](mailto:inaianteixeira@hotmail.com) **Acknowledgements** The Support Foundation of FAPESP [Process: 2012 / 18795-7] for financial support for the development of this research.

### PHYSICAL ACTIVITIES AND PHYSICAL EXERCISE THERAPY FORM REDUCING BLOOD PRESSURE AND HEART RATE FOR BETTER QUALITY OF LIFE.

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**Introduction** The beneficial effects of physical exercise must be recovered in the initial treatment of hypertensive individuals. In sedentary and hypertensive individuals, clinically significant reductions in blood pressure can be achieved with relatively modest increase in physical activity, above the sedentary levels, in addition to the amount of exercise required to lower blood pressure may be relatively small, possible be achieved even by sedentary individuals (Bankoff and Zamai, 2012). **Methods** We evaluated 114 male subjects aged 35-55 years, mean age 46 years using a questionnaire containing the name, weight, height, blood pressure measurements, heart rate, power, sedentary lifestyle, chronic diseases and other issues. We separated the 37 questionnaires which caught our attention for the results. It was proposed to them a program of moderate physical activity 03 times a week last in gone hour each class totaling three hours per week. It was also suggested that they look for other activities outside the program. The prescription of physical activity was: Monday walking, stretching exercises and a series of breathing exercises; Wednesday free dance movements individual and double and Thursday physical activities and guided free exercises for a period of six months. After six months they were reevaluated considering the same variables. **Results** There was a reduction of blood pressure and resting heart rate, reduction in anthropometric measurements and body mass index of the subjects studied; there was a change in eating habits and reducing deleterious habits for health promoting better quality of life. **Surveys data** -1st prior to physical activity program and 2nd before the physical activity program after six months of constant physical activity related to systolic blood pressure, diastolic blood pressure, heart rate, Average age, weight, height and BMI were treated statistically through the ANOVA test: two criteria, were significant at  $p < 0,01$ . **Discussion** Carvalho (2013) describes that ballroom dancing has been used as a means of fitness, with the adoption of varied rhythms in cardiac rehabilitation. Regular exercise can also improve myocardial blood flow and slow the progression of heart disease, or at least maintain an adequate blood supply to the heart muscle to compensate the coronary arteries narrowed by fatty deposits within its walls (Bankoff and ZAMAI 2012; Bankoff et al 2013) **References** Bankoff, ADP ; Zamai, C A ; Rocha, J ; Guimarães, P R Mendes. Study on little active and sedentary women: Comparison between protocols and prospects for admission in physical activity program. *Open Journal of Preventive Medicine*, v. 03, p. 413-419, 2013. Bankoff, ADP; Zamai, CA. Effects of a Physical Activity Program on Cardiac Cycle Events in Sedentary Individuals. *Journal of Clinical & Experimental Cardiology*, v. 3, p. 1-6, 2012. Carvalho, T, Gonzáles, Al; Sties, SW; Carvalho, GMD. Reabilitação cardiovascular, dança de salão e disfunção sexual Arq. Bras. Cardiol. v.101, n.6, p. 134-136, 2013.

### CONSCRIPTS PHYSICAL PERFORMANCE COMPARISON BEFORE AND AFTER BASIC TRAINING COURSE IN 2012 AND 2013

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**Introduction** The purpose of this study was to compare the physical ability level before and after Basic Training Course (BTC) of the conscripts. Service in defense forces requires high moral volition level and good physical ability. Quick adaptation with the new conditions are also important because of the short duration of military service (in Estonia 8-11 months). With good physical preparation conscripts can adapt quickly with service and with new living conditions. **Methods** The sample of this study consists of conscripts who began service in 2012 (n=3235 conscripts) and in 2013 (n=3255 conscripts). To assess soldiers physical condition and their progress of training suitability we use in Estonian Defense Forces (EDF) the United States Army Physical Fitness Test (PFT) which is modified for the EDF demands. PFT is designed to test the muscular strength, endurance, and cardiovascular respiratory fitness of soldiers (Army Physical Readiness Training 2012). The test consists three different exercise: (1) push-ups in two minutes; (2) sit-ups in two minutes and (3) 3.2 kilometers run. Scoring of the PFT is based on gender, age category and number of repetitions performed, where each event ranges from 0 to 100 points. The sum of the three exercises must be more than 190 points to pass the PFT. All soldiers in EDF must do the PFT; first test at the start of the BTC, second at the end of the BTC and third at the end of the service time. In this study we focus on first two tests. **Results** The PFT analysis revealed that in 2012 passed the first test successfully 38.6% of conscripts. After 10 week BTC, where conscripts have been getting regular physical exercise training lessons, 87.4% of conscripts passed the second physical performance test. In 2013 the first test passed successfully 42.3% and after BTC the number of successfully passed conscripts is raised up to 92.7%. Both results are higher in 2013 than in 2012, although the results were not statistically significant. **Discussion** In conclusion we can say that the physical preparation of the conscripts are very different before military service. By USA Fitnessgram standard (Meredith, Welk 2007) for 17-18 year-old boys are minimum requirements in push-up test 35 and in sit-up test 43 repetitions. To pass the PFT (190points), the requirements are almost the same: 40 push-ups, 46 sit-ups and run 3.2 km in 15.54 minutes. While conscripts physical condition at the beginning of BTC are lower than the minimum requirements are, is necessary to raise their physical ability level before military service, to make BTC more effective for conscripts. **References** Meredith M, Welk G. Fitnessgram/Activitygram. Test administration manual. The Cooper Institute, Dallas, Human Kinetics, 2007. Army Physical Readiness Training. (2012) FM 7-22, HQ, Department of the Army, Washington, DC, USA.

### PHYSICAL ACTIVITY AND CARDIORESPIRATORY FITNESS AS PROTECTIVE FACTORS TO HEALTH INDICATORS IN STUDENTS IN FULL TIME SCHOOL IN THE COUNTRYSIDE

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**Introduction** Physical activity (PA) in schools has been discussed, whether in regular (or extracurricular classes or back turn. Students on Full Time schools have up to 7-9 hours of PA. **Methods** 117 students in Full Time school (60 girls), mean age of  $11.9 \pm 0.9$  years, answered the PA - 3DPAR questionnaire. PA was categorized as  $< 300$  or  $> 300$  minutes/week (min/w). Weight, height and waist circumference (WC) were evaluated and body mass index (BMI) Z scores were calculated. Individuals were classified as normal weight and overweight. Cardiorespiratory fitness (CR) was determined by the maximum  $VO_2$  during the Come and Go 20 meters Test proposed by Léger. Students were grouped according to PA and CR in - CF weak/very weak and PA  $< 300$  min/w, CF weak/very weak and PA  $> 300$  min/w, CF satisfactory and PA  $< 300$  min/w, and finally CF satisfactory and PA  $> 300$  min/w. The program STATISTIC and the square x2 test for linear trends were used. **Results** 21 students (18.8%) were overweight, 25% in the group CF weak/very weak and PA  $< 300$  min/w, whereas 75% were considered CF satisfactory and PA  $< 300$  min/w ( $p = 0.02$ ). 12 students (10.3%) had increased WC, 6 with CF weak/very weak and PA  $< 300$  min/w and 6 with CF satisfactory and PA  $< 300$  min/w ( $p = 0.0003$ ). Only 4 students (3.6%) had increased BP, all with CF satisfac-

tory and PA < 300 min/w. Among the remaining students with normal weight, normal BP and normal WC, the majority had CF satisfactory and PA < 300min/w. Approximately 30% of them were considered CF satisfactory and PA >300 min/w. Discussion The majority of the students had PA < 300 min/w, despite the spent time at school. CF weak/very weak were seen only among those with overweight and increased WC. Students with appropriate WC and BMI presented with CF satisfactory. The best CF has already been reported between countryside individuals<sup>1</sup>. The large number of students of rural school that self-assessed with PA <300 min/w may be due to the fact that the student be adapted to the daily routine like to travel to school on foot or by bike, not considering these activities as severe / very severe, demonstrating the positive influence of the activities, habits and customs of the country side CF these individuals. Conclusion Programs aimed to increase PA along with improved levels CR should be encouraged. References GLANER, M. F. Physical activity level and health-related physical fitness in rural and urban boys. *Rev. paul. Educ. Fis., São Paulo*, 16(1): 76-85, jan./jun. 2002. Contact lilian-messias@yahoo.com.br

## MUSCULOSKELETAL PATHOLOGY EPIDEMIOLOGY FOR MILITARY PERSONNEL AND CIVIL GROUPS

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Introduction Musculoskeletal pathology forms a high rate of morbidity in groups of civil population and military personnel. Musculoskeletal disorders manifest with pain symptoms and functional disorders that have an influence upon daily activity and working capacity. Three most important pain areas are those of lumbar / sacral part, shoulders and lower extremities. It is important to recognize risk factors and their impact upon individual in order to provide preventive measures and reduce the rate of musculoskeletal disorders linked to specific job and treatment at an early stage. The nature of musculoskeletal problems suggest that a combination of ergonomic and individual/organizational intrinsic and extrinsic factors associated to military environment, as well as psychosocial factors may play a role in development, exacerbation and maintenance of work disability in groups of military and civil population. Material and method We provide with assessment of Anthropometric characteristics in two groups. Anthropometric characteristics of military personnel (men; n=60) that leave active service and civil population in the same age range (men; n=100) were collected during a two-year period (2011/2012). Evaluated anthropometric characteristics were height, body mass and anthropometric indices. Body fat ranges for standard adults were calculated according to NIH/WHO body mass index (BMI) guidelines. Data collected by anonymous survey also showed the number of smokers and revealed information on medical history of parents. Results BMI with Musculoskeletal pathology above standard level was identified in 55% of military personnel group cases and in 71.3 % of civil population group cases. Analysis of anthropometric characteristic revealed that above standard level BMI was identified in 61.3 % of soldiers and 73.7 % of officers with musculoskeletal pathology (deforming dorsopathies as the most frequent one). In 14% of cases regarding the civil population group the diagnosis – deforming cervical or lumbar Spondilosis – was confirmed. It was defined that complaints about back pain, which could possibly lead to deforming spondilosis, appear earlier in case of smokers comparing to non-smokers, however the index is statistically insignificant ( $p \geq 0.05$ ). Conclusions Musculoskeletal pain frequently affects daily activities of patients. One of the reasons the musculoskeletal pathology is the overweight it may be important to provide preventive measures to reduce the risk of musculoskeletal disorders linked to specific job and treatment at early stage. Assessment of risk factors (smoking, genetic, inflammation, inappropriate physical exercise) in an early stage of musculoskeletal disorders allowed starting prophylactic and therapeutic measures for maintaining work capacity and health standards.

## SHORT- AND LONG-TERM EFFECTS OF 10-WEEK CYCLE ERGOMETER INTERVENTIONS FOR OLDER ADULTS IN ASSISTED LIVING FACILITIES

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Introduction Regular participation in physical activity (PA) has been shown to reduce the impact of aging. However, many older adults, especially those with functional limitations, are not regularly involved in PA. Therefore, the promotion of PA should be considered as a public health priority in this population. The aim of the current study was to evaluate the short- and long-term effectiveness of 10-week cycle ergometer interventions on PA, functionality and muscle strength in older adults in assisted living facilities. Methods Eight assisted living facilities (n=95; 82.1±5.9 years) were randomly assigned to (1) structured coaching (STRUC), consisting of three weekly supervised sessions on a cycle ergometer, (2) need-supportive coaching based on the Self-Determination Theory (NEED), consisting of an individualized cycle ergometer program with minimal coaching contact, or (3) a control group (CON). Initial training volume was based on a 6-minute cycle test and was gradually increased over the 10-week period. Outcome measurements were training adherence rate (number of training sessions performed as a percentage of the recommended number of training sessions), self-reported PA (using the Physical Activity Scale for Elderly), objectively measured PA (using Sensewear armbands), 6-minute walk distance, modified Physical Performance test (mPPT) and static knee extension strength. Measurements were performed at baseline, post-intervention (10 weeks after pre) and at follow-up (24 weeks after post). Results Adherence to the 10-week program was higher in STRUC (89±13%) compared to NEED (68±31%,  $p=0.001$ ). However, adherence rates were similar in the long-term, although training volume was higher in STRUC. Self-reported moderate intensity PA increased more from pre to post in STRUC and NEED compared to CON ( $p=0.034$ ). However, only NEED showed short-term gains in daily energy expenditure. Adherers (at least 80% of training sessions from pre to post) showed better short-term results on mPPT and knee extension strength. Conclusions Minimal contact with a coach is sufficient to promote cycle ergometer use among older adults in assisted living facilities. Although more structure and assistance of a coach during the initial period resulted in higher training volumes, a limited number of contact moments is favored as it is more feasible in real-life settings. The effects on functionality and muscle strength of our short-term ergometer interventions were limited, but there is potential for improvement. Further research is required to assess the effects of PA programs of longer duration and at higher intensities in assisted living facilities. Contact Eeven.vanroie@faber.kuleuven.be

## APPLICATION OF SOMATIC MOVEMENT EDUCATION FOR TEACHING PILATES TO MIDDLE-AGED WOMEN

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Introduction Pilates is a physical training system created by Joseph Pilates in 1990. In the general public's understanding, it focuses on the training of our core muscles. This physical training system emphasizes breathing, concentration, control, movement flow, core muscles,

and precision. Other than strengthening our muscles, the main goal is to establish a mind and muscle connection through these fitness exercises. Based on the Theory of Somatics, the somatic movement approach enhances one's self-awareness to the structure and capabilities of their own body through a series of physical exercises. The concept is similar with the main principle of Pilates exercise. For the reason that, the purpose of this study was to examine the effect of the curriculum underlying somatic movement education on perceived benefits of Pilates among middle-aged adults. Method Three participants, who were accepted an 8-month Pilates program, 60 minutes per week, were recruited from a private fitness club. Semi-structured interviews were conducted at the end of the program to collect data regarding suggestion for course contents and perceived benefits in mental and physical aspects. The trustworthiness of the data was identified by the principles of triangulation. Result The result revealed a positive feedback about the application of somatic movement education to the Pilates course. The participants reported that the program could enhance their self-awareness to the structure and capabilities of their own body, and maintain healthy and energetic. Moreover, they did self-practice after the class at home, expected the curriculum, and exhibited a positive attitude toward the whole program. Conclusion The results indicated that the Pilates curriculum incorporating somatic movement approach was highly appraised by the participants. The application of somatic movement approach to Pilates class is beneficial to enhance learners' self-awareness of body, relaxation, and physical fitness. This study suggests that the Pilates instructors can design a systematic curriculum underlying somatic movement education, which will be helpful for participants to gain more mental and physical benefits. References Martha Hart Eddy (2002). *Journal of Dance Education*, 2(4), 119-127. Lisa Marie Bernardo (2007). *Journal of Bodywork and Movement Therapies*, 11, 106-110. Williamson, Amanda (2009). *Journal of Dance & Somatic Practices*, 1(1), 29-45. Contact xu3xu6jo3@yahoo.com.tw

### BONE CHARACTERISTICS AND ANTHROPOMETRY IN HUNGARIAN MALE ELITE ATHLETES

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**Abstract Introduction** The beneficial effects of regular physical activity on bone status seems evident. Anthropometric parameters of athletes differ by sports. The main goal was to find and analyse the relationships between bone and anthropometric variables in elite athletes. **Materials and Methods** Participants were (N=184) Hungarian male elite athletes [kayak-canoe (KC=43); triathlon (T=16); track and field (TF=46); water polo (WP=19) and age-matched non-athletic control males (C=60)]. Anthropometric measurements were taken according to the suggestion of International Biological Program. Physique was characterised by Heath-Carter somatotype. Calcaneal Quantitative Ultrasound (QUS) parameters were registered with Sonost 3000 densitometer. The analysis included speed of sound (SOS, m/s), broadband ultrasound attenuation (BUA, dB/MHz), bone quantity index (BQI= $\alpha$ SOS+ $\beta$ BUA,  $\alpha$ ,  $\beta$ : temperature corrections). Differences of the subgroups and correlation patterns were analysed ( $p < 0.05$ ). **Results and Discussion** There were significant differences of QUS parameters between subgroups. Decreasing order of the bone characteristics' quality was as follows: TF; KC; T; WP and C groups. SOS in TF: 1519.30±16.00; KC: 1512.91±20.80; T: 1505.61±12.41; WP: 1500.24±16.95; C: 1495.15±10.85. BUA was the smallest at WP. TF: 106.51±14.82; T: 98.92±11.49; KC: 98.73±16.48; C: 92.20±8.83; WP: 79.42±20.55. BQI in TF: 91.97±16.67; KC: 84.76±19.63; T: 79.23±13.08; WP: 73.71±18.58; C: 69.31±10.05. Relative muscle mass related positively, absolute bone measurements related inversely to bone parameters. Moderate correlations were found between bone parameters and somatotype, especially with endomorphy component. Higher QUS values associated with lower endo- and mesomorphy while more linear physique was related to better bone variables. **Conclusions** Type of exercise and physique appear to affect bone status. Both weight-bearing and non-weight bearing exercise improve bone characteristics in different degrees.

### POSTPRANDIAL ARTERIAL STIFFNESS IN EXERCISE-TRAINED VERSUS UNTRAINED MEN

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**Introduction** Postprandial hyperglycemia increases arterial stiffness (Baynard et al. 2009). Arterial stiffness (Vaitkevicius et al. 1993) and insulin resistance (Weiss et al. 2014) were lower in exercise-trained humans than in untrained humans. However, the effect of exercise on arterial stiffness after glucose ingestion in young adults remains unknown. The present study investigates the effect of aerobic exercise on arterial stiffness after glucose ingestion in young men. **Methods** Ten exercise-trained males (ETR; age, 21.0 ± 0.2 y) and 9 healthy untrained males (UTR; age: 22.0 ± 0.7 y) participated in this study. Carotid-femoral pulse wave velocity (PWV) reflecting central (aortic) arterial stiffness and femoral-ankle PWV reflecting peripheral (leg) arterial stiffness were measured using an automated oscillometric device. Brachial and ankle blood pressure (BP) and heart rates were simultaneously measured using an automatic oscillometric device and electrocardiography during waveform recording. Blood glucose was measured using the glucose oxidase method. All parameters were measured before (baseline) and at 30, 60 and 120 min after the 75 g oral glucose tolerance test (OGTT). **Results** Aortic PWV did not change from baseline at 30, 60 and 120 min after glucose ingestion in both groups. Leg PWV increased from baseline at 30 ( $P < 0.01$ ) and 60 ( $P < 0.05$ ) min after glucose ingestion in the UTR, but not in the ETR group. Leg PWV was significantly higher at 30 min after glucose ingestion in the UTR, than in the ETR group ( $P < 0.05$ ). Brachial systolic BP did not change from baseline at 30, 60 and 120 min after glucose ingestion in both groups. Ankle systolic BP increased from baseline at 30 ( $P < 0.01$ ) and 60 ( $P < 0.05$ ) min after glucose ingestion in the UTR, but not in the ETR group. Ankle systolic BP 30 min after glucose ingestion was significantly higher in the UTR, than in the ETR group ( $P < 0.05$ ). Blood glucose increased from baseline at 30 ( $P < 0.01$ ) and 60 ( $P < 0.05$ ) min after glucose ingestion in both groups. **Discussion** It is well known that leg PWV and systolic BP are decreased after one bout of aerobic cycling (Kingwell et al. 1997). Moreover, Beck et al. (2013) reported that 8 weeks of aerobic exercise reduced leg PWV and SBP in young adults. Thus, regular aerobic exercise might attenuate the increase in leg PWV and ankle SBP after glucose ingestion. The present findings indicate that regular aerobic exercise suppresses increases in postprandial arterial stiffness. **References** Baynard T, Carhart RL Jr, Weinstock RS, Ploutz-Snyder LL, Kanaley JA. (2009). *Eur J Appl Physiol*, 107(3), 299-308. Vaitkevicius PV, Fleg JL, Engel JH, O'Connor FC, Wright JG, Lakatta LE, Yin FC, Lakatta EG. (1993). *Circulation*, 88(4 Pt 1), 1456-62. Weiss EP, Royer NK, Fisher JS, Holloszy JO, Fontana L. (2014). *Med Sci Sports Exerc*, 46(6), 1098-103. Kingwell BA, Berry KL, Cameron JD, Jennings GL, Dart AM. (1997). *Am J Physiol*, 273(5 Pt 2), H2186-91. Beck DT, Martin JSI, Casey DP, Braith RW. (2013). *Am J Hypertens*, 26(9), 1093-102. Contact [ 14n0003@nittai.ac.jp ]

## AGE-RELATED CHANGES IN GROUND REACTION FORCE PARAMETERS DURING SIT-TO-STAND MOVEMENT IN MEN AGED 18–92 YEARS

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**Introduction** Muscle power tends to decline more rapidly than muscle strength with age. The ability of the leg extensor muscles to rapidly develop force is important for performance and has shown to contribute to several activities of daily living, such as sit to stand and stair climbing. The aim of this study was to investigate age-related changes in ground reaction force (GRF) parameters during a sit-to-stand (STS) movement in Japanese men aged 18–92 years. **Methods** Participants comprised 484 healthy adult men, aged 18–92 years. All participants were free of cardiovascular, respiratory and neuromuscular diseases. Subjects sat on a chair of standard height (40 cm) with their feet on a force plate and stood as quickly as possible. The body weight overshoot (SUI), rate of rise in GRF (RFD) and reaction time (RT) data were collected on the computer during STS movement (Freming et al., 1991; Chang et al., 1998). **Results** There were significant inverse relationships between SUI ( $r = -0.63$ ,  $P < 0.001$ ), RFD ( $r = -0.68$ ,  $P < 0.001$ ), RFD/kg ( $r = -0.55$ ,  $P < 0.001$ ) and RT ( $r = -0.21$ ,  $P < 0.001$ ) with age. Across the adult lifespan all GRF parameters (SUI, RFD, RFD/kg and RT) during STS movement decreased by the third decade. The oldest group (80–92 years) had lower RFD (43.7%) and RFD/kg (29.9%) values when compared with the youngest group. Percent changes for RFD and RFD/kg were 9.1% and 5.8% per decade, respectively. **Discussion** The major finding of this study is that the decline in the developing forces production during a STS movement seems to accelerate with advancing age in adult men. Previous studies (Izuquiedo et al., 1999; Kostka et al., 2009) have estimated the relative rate of decline in the explosive force production or anaerobic power to be 10–12% per decade on an average in adult men. In the present study, the percent changes of the decline of RFD and RFD/kg per decade during STS were smaller than that of those results. Further studies are required on how explosive training in addition to strength training can minimize age-related decline in functional capacity. **References** Freming BE, Wilson DR, Pendergast DR (1991) Arch Phys Med Rehabil, 72, 886-889. Cheng PT, Liaw MY, Wong MK, Tang FT, Lee MY, Lin PS (1998) Arch Phys Med Rehabil, 79, 1043-1046. Izuquiedo M, Aguado X, Gonzalez R, Lopez JL, Hakkinen K (1999) Eur J Appl Physiol, 79, 260-267. Kostka T, Drygas W, Jegier A, Zaniewicz D (2009) Int J Sports Med, 30, 225-230. Contact toshiaki@sta.tenri-u.ac.jp

## RELATIONSHIP BETWEEN CURRENT AND PAST PHYSICAL ACTIVITY PARTICIPATION AND BONE HEALTH STATUS IN MIDDLE-AGED AND OLDER WOMEN

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Prevention of osteoporosis has been linked to chronically higher levels of physical activity (PA). Current research indicates that higher amount of weight bearing PA over an individual's lifetime have been associated with greater bone mineral density and slower rates of bone loss in the post-menopausal time period. However, the relationship between current PA and risk for osteoporosis has not been described. **PURPOSE:** The purpose of this study is to evaluate the relationships between past PA history, current PA participation and relevant osteoporosis risk factors with current bone health status in a middle-age and older women. **METHODS:** Forty-three women (age:  $46.9 \pm 6.5$  yrs., BMI:  $24.4 \pm 5.2$  kg/m<sup>2</sup>) in both pre- (n=29) and post-menopausal (n=14) stages volunteers to participate in this study. Subjects completed an osteoporosis risk factors, lifestyle history, and PA history questionnaires. Quantitative Ultrasound method (AOS-1000NW, ALOKA, JAPAN) performed to determine the bone health status (bone mass-OSI) and PA was assessed using a triaxial accelerometer (Active style Pro HJA-350IT, Omron, JAPAN). **RESULTS:** Ten subjects had low bone mass. Age ( $p=0.046$ ) and post-menopausal status ( $p=0.011$ ) were significant predictors of low bone mass. Daily inactive time ( $p=0.159$ ) and small amount of Moderate-to-Vigorous PA (MVPA) ( $p=0.081$ ) were related to low bone mass. PA including weight and non-weight bearing PA were found to not significant predictors of low bone mass. Relationships between MVPA and higher bone mass, and inactivity and low bone mass trend toward statistical significant. **CONCLUSIONS:** This study confirmed both age and post-menopausal status are significant predictors of current low bone mass in this mixed menopausal-stage population. Do not insert authors here

## TO THE QUESTION OF SPORT BALLROOM DANCING INFLUENCE ON THE PSYCHO-EMOTIONAL STATUS OF 35-45 YEARS OLD WOMEN.

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**Introduction** In recent years, ballroom dancing has become increasingly popular and has been widely spread in many countries of the world. **Methods** The methods of psychological testing were used. The indices of reactive anxiety (RA), 'health', 'activity', 'mood' (H.A.M), concentration of attention (AC), emotional (ES) and depression states (DS) of 35-40- years old women in the experimental (n = 18) and control groups (n = 16) were tested. **Results** The advanced information about the motives and needs of women aged 35-45 years have led to the development of a pilot program aimed at the physical and psychological rehabilitation of people going for sport ballroom dancing. The results of mental state of testees show that more noticeable and significant changes ( $R < 0,05$ ) both the experimental and control group were registered in terms of RA, H.A.M and AC. The positive changes in these terms of experimental group are observed in the range of 8,3% to 30,7%, control group – in the range of 4,15 to 22%. It is less in ES of testees. The stabilization is observed in DS with some improvement of terms (3,2% and 1,2% at  $R < 0,05$ ). Probably it can be explained by individual characteristics of people and biological resistance of human emotional and depressive states to the training influences. The largest differences among terms to the side of experimental group there were in CA (over 11,5%), in the terms of «activity» (over 11,2%), RA (over 8,7%) and «health» (over 8,4%), which is obviously related with that the author's technique of training was aimed especially at the «internal» work during the coordination exercises and it was aimed at strengthening of personal feelings. The least differences among groups there were in terms of «mood», ES and DS (resp. over 4,1%, 3,7% and 2,0%). **Discussion** A sufficiently high level of motivation to prolong the active longevity, to save health, to increase life and business activity as well as conscious desire to have a healthy lifestyle and self-improvement have formed the appropriate psychological settings of the engaged people both groups, but more consciously they appeared in the experimental group. These settings and expectations were sustained by the health and mental improvement of involved people, also by the increase in social activity and therefore they have increased the motivation to go in for sport ballroom dancing. **References** Bebik, M. Dance movement therapy as a way to find the creative potential of the dancer by solving psychological problems // Sports dancing. - Bulletin. - M. : RGAVC, 2000. - № 1 (9). - 29-31 p. Kocherin, P. Status and perspectives of development of modern sport dancing/ P.M. Kocherin // Bulletin UIGPU. - Ulyanovsk, 2011. - Edition. 5. - p. 185-188.

## THE EFFECT OF LOW AND MODERATE INTENSITY PHYSICAL EXERCISE ON POSTURAL CONTROL AMONG 65 YEARS OLD AND OLDER MEN

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Despite many long-term health benefits associated with systematic physical activity, a single bout of physical exercise can be associated with changes causing a reduction in the quality of performed motor tasks, including the maintenance of a stable body posture. The aim of the study was to analyze the degree of disruptions in postural control resulting from global exercise of low to moderate intensity in older men. The analysis included the results of 25 men (aged between 65 and 81 years,  $x = 71.6 \pm 5.1$  years). This group was selected based on medical qualification, taking into account the lack of contraindications to moderate physical exercise. The experiment comprised of five sessions (one session for control measurement and four experimental sessions). During the experimental sessions I to IV, the participants were subjected to a 10-minute exercise on a cycloergometer with the intensity set at 15%, 30%, 45%, and 60%  $VO_{2max}$ , respectively. A single session included 2 tests of postural control (P1 – pre-exercise, P2 – post-exercise). The postural control was examined with AccuGait™ posturographic force plate (PJB-101, AMTI). Subjects were given the task of standing barefooted as still as possible on the force plate with eyes open for 30 seconds. The difference between the centre of pressure (COP) displacements and the centre of gravity (COG) displacements was considered as a parameter of postural control. Both the overall difference (SD) and its components in frontal (SDML) and sagittal (SDAP) plane were taken into account, as well as the elliptic area of the 95th percentile of COP displacements (A95%). The data on COG displacements was obtained as a result of the low-pass filtering of COP signaling. Statistically significant differences (higher post-exercise values) of analyzed parameters were documented during session II, III, and IV for SD ( $p < 0.05$ ,  $p < 0.01$ ,  $p < 0.001$ , respectively) and SDAP ( $p < 0.05$ ,  $p < 0.01$ ,  $p < 0.001$ , respectively). During session IV, also a post-exercise increase in SDML ( $p < 0.001$ ) was documented. No significant changes in the area of COP displacement were noted. The analysis revealed markedly more pronounced (step-wise) deterioration of postural control in older individuals performing exercise with an intensity of 60%  $VO_{2max}$ . Perhaps, due to safety concerns (increased risk of falling), older individuals should undertake exercises of lower intensity (45%  $VO_{2max}$  or lower) during activities of daily living and recreation if not otherwise contraindicated. On the other hand, undertaking exercise of intensity of 60%  $VO_{2max}$  under supervision (rehabilitation, intervention programs) can promote adaptation and gradual reduction of post-exercise disruptions of postural control.

## EFFECTS OF DIFFERENT SCHOOL-BASED PHYSICAL ACTIVITY INTERVENTIONS ON CHILDREN'S MOTOR PROFICIENCY

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**Introduction** To evaluate the effectiveness of two 5-months school-based physical activity (PA) interventions on primary school children's health-related outcomes. **Methods** 230 children were assigned to one of three intervention groups: Traditional PA, Experimental PA, or Control group (no PA intervention). Pre- and post- intervention tests assessed pupils' fitness (The Cooper Institute, 2006) and gross motor coordination abilities (Kiphard & Schilling, 2007). Traditional PA intervention was structured without any specific coordinative request (D.M. n. 254, 16 November 2012) while experimental PA intervention was structured in four different didactic modules focused on specific coordinative abilities proper to sport-games, rhythmic, gymnastics and fitness activities. Results Both Traditional and Experimental PA Groups significantly increased some fitness and coordinative tests (Sit and Reach Test, Curl-Up Test, Push-Up Test, Shifting Platforms Test, Balance Test, Jumping Laterally Test, Motor Quotient) after the intervention period. Control Group decreased significantly on the Push-Up and Balance Tests. Gender significantly affected Sit and Reach, Balance, Jumping on one leg tests and the Motor Quotient score. Specifically, in Sit and Reach Test, both girls and boys of Traditional PA Group improved their performances ( $18 \pm 5$  vs  $20 \pm 5$  cm,  $15 \pm 6$  vs  $17 \pm 5$  cm;  $P < 0.05$ , respectively). Girls' performances of the Control group increased after the intervention ( $17 \pm 5$  vs  $19 \pm 6$  cm;  $P < 0.05$ ), while boys' performance decreased after the intervention period ( $15 \pm 6$  vs  $14 \pm 6$  cm;  $P < 0.05$ ). Only girls improved Balance Test ( $82 \pm 16$  vs  $87 \pm 18$  num;  $P < 0.05$ ) and Hopping on one leg over an obstacle Test after the intervention period ( $54 \pm 11$  vs  $59 \pm 13$  num;  $P < 0.05$ ). Girls showed a more pronounced improvement of Motor Quotient after the intervention period than boys ( $61 \pm 15$  score vs  $69 \pm 14$  score,  $p < 0.05$ ;  $67 \pm 11$  score vs  $72 \pm 13$  score;  $P < 0.05$ , respectively).  $VO_{2max}$  significantly decreased after the intervention period ( $43.51 \pm 2.85$  vs  $42.44 \pm 2.80$  ml · kg<sup>-1</sup> · min<sup>-1</sup>;  $P < 0.05$ ). **Discussion** Results demonstrated the effectiveness of a qualitative school-based PA approach to improve children's motor performance. **References** The Cooper Institute (2006). Fitnessgram/activitygram test administration manual. Champaign, IL: Human Kinetics. Kiphard EJ, Schilling F (2007). Körperkoordinationstest für Kinder. Weinheim: Beltz Test GmbH. D.M. n. 254, 16 Novembre 2012. Ministerial Decree n. 254, 16 November 2012. National Guidelines for the curriculum in kindergarten and the first cycle of education. General Series of the Official Gazette n. 30 of February 05, 2013, n. 30, 65-67. Contact mariachiara.gallotta@uniroma4.it

## HYDROGYMNASTICS TRAINING PROGRAM ON PHYSICAL FITNESS IN ELDERLY WOMEN

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The aim of this study was to evaluate the effect of a hydrogymnastics training program on physical fitness in 26 elderly women (experimental group  $n=16$ , control group  $n=10$ ). The physical fitness was determined by the senior fitness test protocol, the hydrogymnastics consisted in aerobic exercise at 50%-60% of maximum heart rate, 5 times a week in a period of 12 weeks. ANOVA 2x2 as statistical test was used, indicating statistically significant interaction ( $p=0.052$ ) between groups and measurements on test strength endurance in the legs by squatting on chair in 30 s, agility test 2.4 meters was significant interaction ( $p \leq 0.01$ ) between groups and measures, testing aerobic capacity test step 2 minutes ( $p=0.02$ ) and six minutes walk indicated significant interaction between groups and measurements ( $p=0.50$ ), the results shown that hydrogymnastics in the elderly women participants was effective improving endurance, strength and agility mainly in legs.

## COMBINED SCHOOL-BASED PHYSICAL ACTIVITY AND NUTRITIONAL INTERVENTION TO IMPROVE LIFESTYLE IN CHILDREN

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COMBINED SCHOOL-BASED PHYSICAL ACTIVITY AND NUTRITIONAL INTERVENTION TO IMPROVE LIFESTYLE IN CHILDREN Iazzoni, S.1, Gallotta, M.C.1, Emerenziani, G.P.2, Meucci, M.3, Migliaccio, S.1, Guidetti, L.1, Baldari, C.1: *Foro Italico University (Rome, Italy)*, 2: *La Sapienza University (Roma, Italy)*, 3: *Appalachian State University (Boone, USA)* Introduction To evaluate the efficacy of two different combined school-based physical activity (PA) and nutritional interventions on children's lifestyle. Methods 230 students were classified according to their adiposity status (McCarthy, 2006) and they were randomly assigned to a Traditional PA Group (TPA), to an Experimental PA Group (EPA) combined with a nutritional intervention or to a Control group (nutritional intervention). Their weight, height, BMI z-score, fat mass percentage (% FM), lean body mass (LM), total weekly leisure-time PA, sitting time (Godin & Shepard, 1985) and eating habits (Vereecken, 2008) were assessed before and after intervention period. Traditional PA intervention was structured according to the Ministerial Programs of Physical Education (D.M. n. 254, 16 November, 2012). Experimental PA intervention was structured in four didactic modules focused on sport-games, rhythmic, gymnastics and fitness activities. Results %FM increased after intervention (18.9±8.6% vs 19.4±8.5%) in all groups. Total weekly leisure-time PA significantly increased after intervention (72.2±28.2 vs 84.8± 23.7 MET/week). Sitting time significantly decreased after the intervention period (565.7±252.9 vs 492.1±230.9 min/week). Obese children's BMI z-score significantly decreased after intervention (2.0±0.3 vs 1.9±0.3). Children significantly changed the consumption of some specific foods after the intervention period. Consumption of vegetables (3.9±1.6 time/week vs 4.2±1.5 time/week) and fruits (4.3±1.6 time/week vs 4.8±1.7 time/week) increased after intervention period while consumption of sweets decreased in TPA Group (4.5±1.7 time/week vs 5.2±1.7 time/week) and in EPA Group (4.5±1.7 time/week vs 5.2±1.7 time/week). Consumption of sweets decreased in TPA Group (4.5±1.7 time/week vs 5.2±1.7 time/week) and in EPA Group (4.5±1.7 time/week vs 5.2±1.7 time/week). Consumption of drinks decreased in TPA Group (4.1±1.6 time/week vs 2.7±1.5 time/week) and in EPA Group (3.2±1.4 time/week vs 1.4 ±1.3 time/week). Consumption of snacks decreased in TPA Group (3.4±1.8 time/week vs 1.9±0.9 time/week) and in EPA Group (3.0±1.7 time/week vs 2.1±1.3 time/week) while consumption of fruit increased in both group with a combined intervention, respectively, (4.12±1.69 time/week vs 5.21±1.67 time/week; 4.57±1.71 time/week vs 5.25 ±1.77 time/week). Discussion This pilot study revealed the effectiveness of a 5-month combined school-based PA and nutritional intervention to improve children's lifestyle. However, it need of a congruous involvement to maintain patterns of healthful dietary practices and to encourage an active lifestyle.

## PRELIMINARY STUDY ON THE SYNERGISTIC EFFECT OF ACUPUNCTURE USING PRESS TACK NEEDLE AND RESISTANCE TRAINING IN YOUNG ADULTS

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Introduction Press tack needles are small needles (approximately 0.5–1.5 mm long) that are fixed with adhesive plaster, and have the advantage of easy insertion into the epidermis, allowing them to be used during exercise. These needles reportedly reduce pain and fatigue after insertion. Miyazaki et al. performed a double-blind, randomized controlled trial to investigate the effect of press tack needles on lower back pain. The group treated with press tack needles demonstrated significantly lower subjective pain on the visual analogue scale (VAS) than the local anesthesia group (Miyazaki et al., 2009). We conducted a preliminary study to investigate the synergistic effect of acupuncture using press tack needles and resistance-training programs in young adults via a randomized controlled trial. Method Eighteen healthy young male adults aged between 20 and 22 years (mean age, 21.4 ± 0.6 years) were randomly and equally assigned to two groups: the exercise and acupuncture using press tack needle intervention (Pn, n = 9) and resistance training intervention groups (Ex, n = 9). Pn group participants underwent structured acupuncture using press tack needles, and their exercise regimen consisted of home-based resistance training of the lower limbs (squat) using one's own bodyweight. They measured exercise intensity with the newly developed perceived exertion Japanese scale (S-scale, a 4-point scale), and performed repetitions until they reached a perceived exertion intensity of 3 out of 4 for 4 weeks. Ex group participants underwent the same resistance-training program for 4 weeks. The outcome measures were body composition, vastus lateralis muscle thickness, 30-s chair-stand test, vertical jump, rebound jump index, and number of squats during exercise. Evaluation parameters such as subjective leg pain caused by delayed onset muscle soreness were measured on the 100-mm horizontal VAS. Results After 4 weeks of intervention, we identified a statistically significant two-factor interaction between the Pn and Ex groups in terms of the number of squats ( $F = 4.2$ ,  $p < 0.05$ ). However, no statistically significant synergistic effect of acupuncture using press tack needles and resistance training was observed in the other measures. Conclusion These results suggest that the effect of exercise may be slightly enhanced by intervention with concurrent acupuncture using press tack needles. Reference Miyazaki S et al. (2009). Applicability of press needles to a double-blind trial: a randomized, double-blind, placebo-controlled trial. *Clin J Pain*, 25(5), 438-44. Contact terada@sta.tenri-u.ac.jp

## EFFECT OF 12 WEEK NON SUPERVISED WORK PLACE INTERVENTION ON DEPRESSION AND WORK ABILITY OF EMPLOYEES OF UNIVERSITY IN SAUDI ARABIA

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Introduction Workplace gives an ideal opportunity to reach large numbers of people for purpose of promoting good health and preventing disease (Atlantis Et al 2006). Therefore, aim of study was to examine the effect of 12 week non-supervised physical activity intervention on depression and work ability on employees of King Fahd University of Petroleum and Minerals (KFUPM) Saudi Arabia. Methods Participants were 25 employees of KFUPM. Participants were randomly assigned to intervention (n=12) and control group (n=13). Exercise guidelines were issued in form of Leaflets and posters. A formatted diary was given to each participant in intervention group to record his activities. Duration of intervention was 12 weeks (two sessions per week), 30 minutes for each session. Intervention consisted of aerobic and resistance training. Depression symptoms were assessed by PHQ-9 depression scale (Spitzer et al 1999). WAI was used to assess work ability (Tuomi et al 1991). Mann Whitney Test was used to compare differences between intervention and control group. Results There was significant difference between exercise and control group's median depression score (mean ranks of exercise group and control group was 8.64 and 14.36 respectively;  $U = 29$ ,  $P = 0.035$ ). There was no difference between the median WAI scores of the exercise and



control group (the mean ranks of exercise group and control group were 13.55 and 9.45 respectively;  $U = 38$ ,  $p = 0.138$ ). Discussion Depression symptoms in exercise group were reduced significantly after the 12 weeks of non-supervised exercise programme when compared to the control group. Recently a study done by (Zarshenas et al 2013) also confirmed the significant decrease in depression symptoms in experimental group compared to control group ( $p < 0.5$ ). Zeeuw et al, 2010 also confirmed that exercise can reduce the risk of depression in employees with sedentary jobs, an inactive lifestyle, and a high-risk of depression. Although Work ability in the exercise group did not improve significantly but there were sign of improvement. References Atlantis E, Chow CM, Kirby A, Fiatarone MA. *Health Promot Int*, 21, 191–200. Spitzer, R. L., Kroenke, K., & Williams, J. B., (1999). *JAMA*, 282, 1737e-1744. Tuomi K, Ilmarinen J, Eskelinen L, Järvinen E, Toikkanen J, Klockars M. (1991). *Scand. J. Work Environ*, 17 (suppl 1), 67-74. Zarshenas S, Houshvar P, Tahmasebi A. (2013). *Depression Research and Treatment*, 1- 6. Zeeuw ELEJ, Tak ECPM, Dusseldorp W, Ingrid J.M. Hendriksen JM. (2010). *Mental Health and Physical Activity*, 3, 72e-77 Contact rtau@rediffmail.com

### **EFFECTS OF FOUR MONTHS OF PERIODIZED AQUATIC EXERCISE PROGRAM ON FUNCTIONAL AUTONOMY IN POST-MENOPAUSAL WOMEN WITH PARKINSON'S DISEASE**

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Aim: To determine the effect of a periodized aquatic exercise program on functional autonomy in post-menopausal women with Parkinson's disease. Methods: Nine post-menopausal women diagnosed with idiopathic Parkinson's disease, with stage I-III according to Hoehn and Yahr scale, (age  $60.4 \pm 3.87$  years) participated in the 16-week of periodized aquatic exercise program five times a week, 30 minutes of aquatic exercise with work heart rate reserve of 40-50% (1-8th week) increasing the load to 50-60% (9-16th week). The protocol of the Group of Latin-American Development for Maturity (GDLAM) was used to evaluate functional autonomy; As statistical analyses student T test for paired samples was used, also percent changes ( $\Delta$  %) were calculated, the results showed significant improvement ( $p < 0.05$ ) comparing before and after the aquatic exercise program in 10 meters walk test (C 10m) ( $p = 0.001$ ) and general GDLAM index (IAF) ( $p = 0.003$ ), percent changes ( $\Delta$  %) showed positive improvements in the five components of GDLAM. Conclusion: Periodized aquatic exercise program was able to enhance (C 10m) and (IAF) however, will be appropriated in the future more studies to better clarify the possibilities of improvements between aquatic exercise program and functional autonomy in post-menopausal women with Parkinson's disease.

### **PROMOTING OFFICE STANDING VIA POINT OF CHOICE PROMPTS: EFFECTS ON SITTING TIME, CONCENTRATION AND NEUROMUSCULAR PERFORMANCE IN OFFICE WORKERS**

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Introduction Physical inactivity is considered a major public health concern (Blair 2009). Sedentary behavior has been additionally shown to be an independent risk factor for the development of various disease conditions (Li & Siegrist 2012). As prolonged office sitting adversely affect neuromuscular and cardiovascular health parameters, the present study investigated the effects of prompts on occupational sitting and standing time, neuromuscular performance and concentration. Methods A single blinded randomized controlled trial with parallel group design was conducted. Thirty-eight office workers (age: 41 (SD: 11) years, body mass index: 24 (4) kg/m<sup>2</sup>, weekly working hours: 38 (8) hours) with experience in using sit-stand desks were randomly assigned (Strata: PA, BMI, gender, workload) to a prompt (INT) and non-prompt (CON) group. INT received screen-based prompts three times a workday within 12 weeks. CON was only one time instructed about the benefits of using height-adjustable working desks (HAWD) prior to the start of the study. Sitting and standing time were assessed for one entire working week employing the ActiGraph wGT3X-BT and the occupational sitting and physical activity questionnaire (OSPAQ) at baseline, after 6 and 12 weeks. Concentration (d2), postural sway (under single, dual and triple task) and lower limb strength endurance (heel-rise) were collected as secondary outcomes. Results With moderate between group effects at each time point, INT reduced occupational sitting time by -7.3% (CON: -1.7%,  $d = 0.61$ ) after 6 weeks. This is a daily reduction of approximately 30 minutes. Although no further reductions were observed between week 6 and 12 for either group, standing time was still elevated compared to baseline level. Concentration and neuromuscular performance did not differ between both groups after the intervention period (0.23

### **ORTHOOREXIC EATING BEHAVIOR IN RELATION TO HEALTH STATUS AND PHYSICAL ACTIVITY: A COMPARISON BETWEEN STUDENTS IN TWO UNIVERSITY PROGRAMS**

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Background Orthorexia nervosa (ON) is a condition described as 'unhealthy' behaviors regarding diet and physical activity. There is an ongoing discussion if ON is more common among adolescents studying in the area of health care and exercise. The research on ON is scarce and few studies assess ON and its association to health related quality of life (HRQoL). Aim The aim was to study orthorexic eating behavior, levels of physical activity and HRQoL in students enrolled at university programs focusing on health and exercise compared to those enrolled in business programs. Method 128 subjects, 32 men and 38 women from Biomedicine – Athletic Training (Biomedicine) and 22 men and 36 women from Construction and Real Estate Business (Business) participated in this cross-sectional study. The subjects completed the Short Form-36 Health Survey (SF-36) to measure HRQoL, the International Physical Activity Questionnaire (IPAQ) to measure levels of physical activity and ORTO-15 which examines eating behavior. A score less than 40 on ORTO-15 (score ranging from 0-60, worst to best) indicated an unhealthy relation to diet and was considered as ON in this study (Donini et al., 2005). Differences between groups were analyzed with t-tests and chi-square test. Results A total of 105 out of 128 (82%) subjects had a score indicating ON. Students from Biomedicine had a higher frequency of ON in comparison to Business ( $p < 0.000$ ) and in the SF-36 subscale bodily pain, Biomedicine students reported a higher frequency of pain ( $p = 0.006$ ). Results from measurements of physical activity did not differ significantly between Biomedicine and Business students, but there was a trend for high-intensity physical activity to occur more frequently in men than in women in general ( $p = 0.014$ ). Conclusion ON is a common condition in university students and even more frequent in students enrolled in a program directed towards health and nutrition. The high frequency of ON seen in Biomedicine students could be a problem that needs to be addressed since the students, after graduation, are expected to coach other people to a healthy living. Further studies are needed to explore associations with ON to health and physical activity. There is also a need to develop valid and reliable instruments

for assessing the condition. References Donini, L. M., Marsili, D., Graziani, M. P., Imbriale, M. & Cannella, C. 2005. Orthorexia nervosa: validation of a diagnosis questionnaire. *Eat Weight Disord*, 10, e28-32. e-mail: julia.malmborg@hh.se

### EFFECTS OF 12-WEEK CIRCUIT WEIGHT TRAINING AND AEROBIC EXERCISE ON BODY COMPOSITION, PHYSICAL FITNESS, AND PULSE WAVE VELOCITY IN OBESE COLLEGIATE WOMEN

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**Introduction** The obesity caused by an imbalanced intake of calories and decreased exercise has led to related health problems including diabetes, hypertension, and arteriosclerosis, and has worsened the quality of life of young Koreans. The purpose of this study was to study the effects of 12 weeks of circuit weight training and aerobic exercise on body composition, physical fitness, and pulse wave velocity in obese collegiate women. **Methods** Twelve obese collegiate women were randomly assigned either to an exercise training group (TG) or control group (CG). 12-week exercise program was composed of an approximately 40–65 min session of circuit weight training (resistance training and aerobic exercise) as well as jogging at an intensity of 50–70% of the age-predicted heart rate reserve. The circuit weight training program was made by Korean Institute of Sport Science and was modified as needed for obese collegiate women. **Results** The results indicated that after the 12-week intervention, there was a significant interaction of time by group with respect to body weight ( $p < 0.05$ ), % body fat ( $p < 0.01$ ), and WC ( $p < 0.01$ ) and there was a significant change in back strength between the TG before beginning the program and the TG after having completed the program ( $p < 0.01$ ). There was also a significant interaction of time by group with respect to back strength ( $p < 0.01$ ), grip strength ( $p < 0.05$ ), sit and reach ( $p < 0.01$ ), sargent-jump ( $p < 0.01$ ), and the one leg balance with eyes closed ( $p < 0.01$ ). Further, there was a significant interaction of time by group with respect to the 1,200 m run for cardiopulmonary endurance ( $p < 0.01$ ); however, this difference was not statistically significant between the TG pre and TG post. In addition, there was a significant in sit-ups ( $p < 0.01$ ) and the 1,200 m run ( $p < 0.01$ ) between the TG and CG. **Discussion** Our study found that body composition and physical fitness were improved after the combination of circuit weight training and aerobic exercise program in obese collegiate women. Physical activity has positive effects on the occurrence of obesity and changes of physical fitness and therefore, college students need regular exercise (Yoo, 2005; Bensimhon et al., 2006). Further studies are needed that will consider the effects of pulse wave velocity of a combined exercise program, and also to help to identify the intensity, duration and frequency of exercise to attain optimal benefits. References Yoo BK. (2005). *Korean J Exerc Nutr*, 9(3), 253–259. Bensimhon DR, Kraus WE, Donahue MP. (2006). *Am Heart J*, 151,598–603. Contact violethjk@naver.com

### PHYSICAL ACTIVITY DURING PE LESSON AND AFTER-SCHOOL HOURS: ARE THEY ASSOCIATED WITH CHILDREN DAILY PHYSICAL ACTIVITY?

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**Introduction** School-based physical activity (PA), including PE and after-school sport class are possible occasions to increase children daily PA. Recent studies, however, questioned if increasing activity during the school hours may in return compensate children to be less active outside of school. The purpose of this study was to examine the association of school-based PA (i.e., PE class and after-school sport class) in different intensity (i.e., MPVA and sedentary) within various periods (i.e., in school hours and whole day). **Methods** Participants were 212 children with mean age of 8.9 from four local primary schools in Hong Kong. Children's PA level was measured by accelerometer (ActiGraph GT3X) for four consecutive days. Participants reported if they had scheduled PE lesson or participated in after-school sport class on the measurement period. The accelerometer counts derived into the time (min) of MVPA and sedentary behavior using age-specified criteria. Participants were grouped into 1) with PE lesson (PE group); 2) with after-school sport class (AFS group); or 3) no PE or after-school sport class (N-Act group). ANOVA was conducted to examine if children's MVPA and sedentary behavior is a function of the participation of PE lesson or after-school sport class. **Results** Excluding the non-school days data, 514 measurements were entered for analysis. Overall, children school-based MVPA during after-school hours (12.0 min) were higher than in PE lesson (8.6 min). Children daily MVPA was statistically significantly different between groups with various school-based PA participation [ $F(2,125) = 14.6, p < .000$ ] and increased from N-Act group (37.9 min) to PE group (46.1 min) and AFS group (59.5 min). For the sedentary behavior, significant difference was found between groups with various school-based PA participation [ $F(2,511) = 3.4, p = .03$ ] and decreased from N-Act activity (1190 min) to PE group (1173 min) and the AFS group (1151 min). **Discussion** The present study added information on the understanding of children school-based PA participation. First, children's participation in school-based PA was associated with their daily MVPA level, in which children with after-school participation were engaged in higher daily MVPA than their counterparts. The importance of after-school hours and PE class to increase children's PA participation is further confirmed. Second, children daily sedentary behavior was significantly decrease in the group with PE and after-school sport class participation. The involvement in PA during school hours, therefore, may not result in lower daily PA. On the contrary, is possible to enhance the lifestyle PA of children. References Trost, S.G., Rosenkranz, R.R. & Dziewaltowski, D. (2008). *Med Sci Sport Exer*, 40 (4), 622-629. Slingerland, M. & Borghouts, L. (2011). *J Phys Act Health*, 8, 866-878.

### THE RELATIONSHIP BETWEEN AEROBIC FITNESS AND COGNITIVE PERFORMANCE: ROLE OF BRAIN POTENTIALS

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The aim of the present study was to investigate the role of brain potentials in the relationship between aerobic fitness and cognition. Forty-six male subjects participated in this study. The electroencephalographic (EEG) and behavioral data were simultaneously collected when subjects performed an endogenous visuospatial attention task. The results revealed that  $VO_{2max}$  value was associated with faster reaction times (RTs) along with greater P3 amplitude and shorter P3 latency in the valid condition, after accounting for age and body mass index. Moreover, we observed that RTs were related to P3 amplitude, while such effect was not seen for P3 latency. Importantly, the Bootstrapping model result showed that P3 amplitude fully mediated the relationship between  $VO_{2max}$  and RTs. The present study demonstrated that higher levels of aerobic fitness are associated with greater amounts of attentional resource allocation, which may translate into faster processing speed performance.

### THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND VISUO-SPATIAL COGNITIVE FUNCTION IN ELDERLY ADULTS: AN EVENT-RELATED POTENTIAL STUDY

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Physical activity has been shown to be positively related to higher-level cognitive function in late life. However, such effect on visuo-spatial cognition, which was suggested to be sensitive to aging, has been rarely investigated. Here we compared event-related potential (ERP) from physically active elderly adults (aged  $66.63 \pm 1.31$  years; female =10) and age- and gender-matched sedentary counterparts (aged  $67.31 \pm 1.25$  years) when they performed a visuo-spatial cognitive task involving different levels of cognitive load (e.g., attention and working memory conditions). The findings showed that physically active elderly adults had better accuracy on the visuo-spatial cognitive task regardless of levels of cognitive load. In terms of ERP data, the results revealed that elderly adults with higher levels of physical activity displayed greater P3 amplitude at Fz and Pz electrodes across conditions. Moreover, the correlation results showed that physical activity was positively related to accuracy performance in both attention and working memory conditions, and is also positively associated with P3 amplitude during the encoding and retrieval stage in the working memory condition. The results suggest that physical activity may be beneficial for the aging cognition, especially for that having higher vulnerability (e.g., visuo-spatial cognition) to aging.

### Molecular Biology and Biochemistry

#### INFLUENCE OF PHYSICAL EXERCISE AND/OR ENALAPRIL IN THE ASSOCIATION BETWEEN HYPERTENSION AND SLEEP-RELATED MOVEMENT DISORDERS

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The relationship between hypertension and sleep-related movement disorders has been hypothesized for humans, but the causes and mechanisms have not been elucidated. We investigated whether the alteration of blood pressure (BP) induced by physical exercise and/or an angiotensin-converting enzyme inhibitor (enalapril) can affect the locomotor activity of spontaneously hypertensive rats (SHR) by acting on the dopaminergic system. We used SHR and normotensive Wistar rats distributed into 4 groups for each strain: Control, Physical Exercise, Enalapril and Enalapril+Physical-Exercise. Physical exercise was performed on a treadmill and enalapril was administered by gavage, both for 8 weeks. During this period, locomotor activity was evaluated in an open field test and BP was evaluated by tail plethysmography. Dopaminergic receptors, dopamine transporter and tyrosine hydroxylase in the striatum were evaluated by western blot. The control SHR group showed higher BP, more activity in the open field test and lower levels of D2 receptor and tyrosine hydroxylase compared with all other groups throughout the experimental period. In general, physical exercise and enalapril attenuated these alterations. This study suggests the existence of comorbidity between hypertension and sleep-related movement disorders in SHR, which is mediated by dopaminergic changes. Physical exercise and enalapril conferred protection from both hypertension and the observed behavioral changes.

#### SERUM FAS-LIGAND AND MIR-21 LEVELS AND THEIR ASSOCIATIONS WITH PHYSICAL PERFORMANCE OF MASTER MALE SPRINTERS – A 10 YEAR FOLLOW UP STUDY

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**Introduction** Physical exercise is known to affect the gene regulation and subsequently cause changes in the phenotype. MicroRNAs (miRs) are small molecules which form a crucial part of the regulatory system by blocking the protein translation of several genes. In untrained people, aging has found to be associated with changes in the levels of certain miRs and other circulating molecules such as an apoptotic marker FasL. **Methods** In the current study we investigated the interplay between serum miRs, FasL and physical performance of master sprinters (n=50) aged 40 to 85 years at the baseline in a 10 year follow up study design. Paired sample test was used for comparison analysis and Generalized Estimating Equations (GEE) models were constructed to model longitudinally the effects of miR and FasL on performance measures. **Results** Our results showed that serum FasL concentrations decreased ( $p=0.016$ ) and serum miR-21 levels increased ( $p=0.034$ ) among all the sprinters during 10 years. When grouping the athletes into 3 different age groups the changes were most significant for FasL among the youngest sprinters aged 40 to 55 at baseline ( $p=0.009$ ) and for miR-21 among the oldest, aged 70 to 85 ( $p=0.004$ ). In GEE models with age as a time scale, FasL had a significant main effect on knee extension strength ( $p=0.016$ ), bench press ( $p<0.001$ ), countermovement jump (CMJ) ( $p=0.032$ ) and 60m sprint performance ( $p=0.025$ ). Quadratic interaction effect with age modified the FasL effect on knee extension strength (age $\times$ FasL,  $p=0.026$ ; age $^2$  $\times$ FasL,  $p=0.040$ ), bench press (age $\times$ FasL,  $p<0.001$ ; age $^2$  $\times$ FasL,  $p<0.001$ ) and CMJ (age $\times$ FasL,  $p=0.030$ ; age $^2$  $\times$ FasL,  $p=0.025$ ), while the effect on sprint performance was modified by cubic effects (age $\times$ FasL,  $p=0.018$ ; age $^2$  $\times$ FasL,  $p=0.013$ ; age $^3$  $\times$ FasL,  $p=0.010$ ). MiR-21 had significant main effects on bench press ( $p=0.034$ ) and CMJ ( $p=0.035$ ). **Discussion** Master sprinters with long-term training and competition background are a unique model to study aging itself, since the accumulations of conditions and diseases caused by sedentary lifestyle, are ruled out. Aging effect in the FasL and miR-21 levels was detected among the study participants. Potentially, circulating markers including FasL and miR-21 could be used as tools in determining the state of a physical performance of an athlete. **References** Kavathia N, Jain A, Walston J, Beamer BA, Fedarko NS. (2009) Aging, Jul 14;1(7):652-63 Olivieri F, Spazzafumo L, Santini G, Lazzarini R, Albertini MC, Rippon MR, et al. Mech Ageing Dev (2012) Nov-Dec;133(11-12):675-8 Korhonen MT. Effects of aging and training on sprint performance, muscle structure and contractile function in athletes [dissertation]. 2009 Contact reeta.kangas@jyu.fi

#### WHETHER REGULAR EXERCISE IN THE JUVENILE PERIOD PREVENTS DEPRESSION-LIKE BEHAVIOUR IN THE MATURATION PERIOD

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The purpose of this study was to investigate whether regular exercise during childhood can prevent depression-like behaviour induced by psychological stress during maturation. Male 5-week-old C57BL/6 mice were randomly divided into three groups: (I) Control (C) mice

were involved in the behavioural test at the same time as other groups, i.e. after 18 weeks of feeding period, (2) Stressed (S) mice did not exercise during the juvenile stage; they were fed for 16 weeks, and then they underwent the behavioural test after being stressed and (3) Exercise and stress (ES) mice were fed for 12 weeks after finishing exercise during the juvenile stage and underwent the behavioural test after being stressed. The treadmill exercise was conducted for 4 weeks on a thrice-weekly basis at a pace of 15 m/min for 60 min. We tested the behaviour of mice in all groups using the forced swimming and sucrose haemolysis tests to investigate depression-like behaviour. To evaluate neurogenesis, bromodeoxyuridine (BrdU) was intraperitoneally administered to mice before stress. All mice were sacrificed after behavioural tests, and brain slices prepared from harvested brains were immunostained with BrdU to check neurogenesis in the hippocampus. Because brain-derived neurotrophic factor (BDNF) is reported to promote neurogenesis and its expression is increased after exercise, we measured the mRNA expression level of BDNF. C and ES mice underwent stress using the method called social defeat stress for 14 days, which was designed to imitate stress that humans experience. The hippocampal neurogenesis did not significantly differ among the groups; however, BDNF mRNA expression levels significantly increased in the C and ES mice. S mice demonstrated depression-like behaviours, such as long-term akinesia in the forced swimming test, and the BDNF mRNA expression level of this group was significantly higher compared with that in the resting group. The sucrose haemolysis test did not reveal any significant difference among the groups in the first 3 days. However, on the fourth day, sucrose consumption was significantly lower in the S mice compared with that in the C mice, demonstrating depression-like behaviour, such as insensitivity, in the S mice, but sucrose consumption in the ES mice did not show any significant difference. These findings suggest that regular exercise during childhood may reduce depression-like behaviour induced by psychological stress in the maturation period.

### OSTEOCALCIN GENE POLYMORPHISM AND BONE DENSITY IN HUNGARIAN ATHLETES

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**Introduction** Osteoporosis is a public health problem, mainly determined on the basis of bone mineral density. The rs1800247 polymorphism of the osteocalcin gene is associated with bone mineral density. The aim of the study was to examine the possible connection between the polymorphism and the bone ultrasound parameters in Hungarian population, including elite athletes. **Methods** A total of 302 subjects participated in the study. Genotype analysis was carried out via a DNA chip, anthropometric measurements were taken according to the International Biological Program. 63 of the participants were also measured by calcaneal ultrasound bone densitometer. **Results** The genotype frequencies of osteocalcin polymorphism in the total sample were: 59.9 % hh, 36.1 % Hh and 3.97 % HH. We separated the 63 subjects by the presence or absence of H allele and there were no significant differences between the two groups neither in the anthropometric, nor in the ultrasound parameters. Grouping the sample by genotypes, no difference was detectable in any of the bone characteristics. Athletes compared to the controls had significantly higher results in all of bone ultrasound values. **Conclusion** The polymorphism of the osteocalcin gene showed no effect on bone quantity in the examined Hungarian population. All of the ultrasound characteristics were greater in the athletes compared to the control group. **References** Lorentzon M, Lorentzon R, Nordstrom P. Vitamin D receptor gene polymorphism is related to bone density, circulating osteocalcin and parathyroid hormone in healthy adolescent girls. *J Bone Miner Res.* 2001; 19:302–307. Jouanny P, Guillemin F, Kuntz C, Jeandel C, Pourel J. Environmental and genetic factors affecting bone mass. Similarity of bone density among members of healthy families. *Arthritis Rheum.* 1995;38(1):61-67. Gustavsson A, Nordström P, Lorentzon R, Lerner UH, Lorentzon M. Osteocalcin gene polymorphism is related to bone density in healthy adolescent females. *Osteoporos Int.* 2000;11(10):847-51.

### THE EFFECT OF ESTROGEN ON THE RECOVERY PROCESS OF DAMAGED SKELETAL MUSCLES –USING HSP70 AS A MARKER–

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**Introduction** This study investigates gender differences in the damaged muscle recovery process by observing the relationship between the female hormone estrogen and HSP70 in damaged skeletal muscles. **Methods** Damaged muscles were created by administering 0.5% bupivacaine hydrochloride (BPVC) to the tibialis anterior muscle. Fourteen-week-old male Wistar rats were divided into four groups, i.e., a control group (Group C) (n=6), an estrogen-administered group (Group E; 40mg/kg) (n=6), a BPVC-administered group (Group B; 5ml) (n=6), and a group that received both estrogen and BPVC (Group EB; 40mg/kg, 5ml) (n=6). The tibialis anterior muscles of rats in Group B and Group EB were isolated 3, 5 and 7 days after BPVC administration. The tibialis anterior muscles in Group C and Group E were harvested on the day corresponding to post-BPVC day 3 in other two groups. HSP70 expression was measured by Western blot analysis of homogenized tibialis anterior muscles. **Results** At 5 days after BPVC administration, the HSP70 expression level in the tibialis anterior muscle was markedly higher in Group EB than that in Group B. The HSP70 expression levels at 3, 5 and 7 days after BPVC administration were increased in the estrogen-treated rats compared with those in non-treated group. There was no difference in HSP70 expression between Group C and Group E. **Discussion** These results demonstrated that HSP70 expression was promoted early in the damaged muscle recovery process in male rats that received estrogen, suggesting a possible difference between males and females in the recovery process of damaged muscles.

### FIBRINOLYTIC ACTIVITY IS INHIBITED AFTER ACUTE STRENUOUS EXERCISE IN YOUNG OVERWEIGHT MEN

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**[Introduction]** Some studies reported an increase in fibrinolytic activity after acute strenuous exercise. Conversely, some studies reported a state of low-grade inflammation and inhibited fibrinolytic activity in overweight subjects. The present study aimed to evaluate whether being overweight affects fibrinolytic activity after acute strenuous exercise. Overweight was defined using body mass index (BMI) as a measure of the degree of obesity. **[Subjects and Methods]** Twelve healthy young men 19 to 23 years old who engaged in daily exercise participated in this study. Based on the definition of overweight as a BMI  $\geq 25$  kg/m<sup>2</sup>, seven and five participants were categorized in the BMI <25,  $\geq 25$  group, respectively. Venous blood samples were collected from the subjects before and after performing the Cooper test which involved running as far as possible within a 12-minute period. IL-6 (inflammatory cytokine) and E-selectin (adhesion molecule expressed on endothelial cells) levels were measured using the blood samples collected before the Cooper test.  $\alpha 2$ -plasmin inhibitor / plasmin complex (PIC, as a marker of fibrinolytic activity) levels were measured using the blood samples collected before and after the

Cooper test. [Results] Values are shown as mean  $\pm$  standard error (SE). Characteristics of the BMI <25 group were age,  $20.8 \pm 0.5$  years; height,  $175.2 \pm 1.4$  cm; weight,  $63.8 \pm 0.7$  kg; and BMI,  $20.8 \pm 0.4$  kg/m<sup>2</sup> and those of the BMI  $\geq 25$  group were age,  $20.0 \pm 0.4$  years; height,  $167.4 \pm 3.3$  cm; weight,  $92.6 \pm 5.9$  kg; and BMI,  $33.1 \pm 2.0$  kg/m<sup>2</sup>. The IL-6 levels were significantly higher in the BMI  $\geq 25$  group than in the BMI <25 group ( $1.1 \pm 0.2$  and  $0.5 \pm 0.05$  pg/mL, respectively;  $p < 0.05$ ). The E-selectin levels were significantly higher in the BMI  $\geq 25$  group than in the BMI <25 group ( $48.7 \pm 3.3$  and  $35.0 \pm 4.4$  ng/mL, respectively;  $p < 0.05$ ). The PIC levels increased significantly in the BMI <25 group (before and after the Cooper test,  $0.5 \pm 0.02$  and  $1.8 \pm 0.3$   $\mu$ g/mL, respectively;  $p < 0.01$ ), but these were not significantly increased in the BMI  $\geq 25$  group ( $0.5 \pm 0.08$  and  $0.9 \pm 0.1$   $\mu$ g/mL, respectively;  $p > 0.05$ ). [Conclusions] We speculated that the BMI  $\geq 25$  group was in the state of low-grade inflammation compared with the BMI <25 group. This study showed that being overweight induced a low-grade inflammatory state, and fibrinolytic activity is inhibited after acute strenuous exercise.

### INACTIVATION OF SOCS3 IN LEPTIN RECEPTOR EXPRESSING CELLS PROTECTS MICE FROM HYPERPHAGIA AND WEIGHT REGAIN AFTER A CALORIE-RESTRICTED PERIOD

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Calorie-restricted diets can be an efficient nutritional intervention to promote weight loss in obese subjects. However, the long-term success in maintaining the weight lost is usually poor because individuals tend to eat more after dieting. So, putative interventions that could attenuate the hyperphagia after a period of caloric restriction could have a substantial impact on obesity treatment success rate. Leptin is a key hormone for the long-term regulation of body weight. Leptin resistance is a hallmark of obesity and some proteins such as the suppressor of cytokine signaling 3 (SOCS3) plays an important role in inhibiting leptin signaling. Because fasting-induced hyperphagia takes a relatively long time to cease (several days in mice), we hypothesized that SOCS3 may play a role in inducing the hyperphagia and weight regain generally observed after a period of caloric restriction. Thus, we generated cell-specific SOCS3 knockout (SOCS3 KO) mice using the Cre-loxP system by deleting *Socs3* gene only in leptin receptor-expressing cells. SOCS3 KO mice and control (CON) littermates were fasted for 48h and then refed ad libitum for 7 days. SOCS3 KO mice showed an attenuated food intake and weight regain during the refeeding days. We euthanized SOCS3 KO and CON mice in ad libitum state and after 48h fasting, 1, 3, 5 and 7 days of refeeding. Both groups exhibited a decreased circulating leptin levels during fasting. However, while leptin levels in CON group increased above basal levels during the refeeding period suggesting a leptin resistance state, leptin levels remained at the basal levels in the SOCS3 KO group. We performed gene expression analyses in the hypothalamus and only the CON group exhibited an increased SOCS3 mRNA expression after 48h fasting. In addition, 48h fasting caused a peak in the expression of the orexigenic neuropeptides AgRP and **POMC**. This peak was attenuated in SOCS3 KO mice. Furthermore, the expressions of protein tyrosine-phosphatases, which are associated with leptin resistance, were greater in CON group compared to SOCS3 KO group after 1 day (PTPR $\bullet$ , PTPN2) and 5 days (PTP1B, PTPN11, PTPR $\bullet$ , PTPN2) of refeeding. In conclusion, these results indicate that the inhibitory role of SOCS3 in leptin signaling amplifies fasting-induced hyperphagia and weight regain. Therefore, our findings demonstrate that the suppression of SOCS3 is a potential therapeutical approach to prevent weight regain after calorie-restricted diets.

### RESPONSE OF THE CARDIAC PHOSPHOPROTEOME TO A GRADED EXERCISE TEST TO MEASURE PEAK OXYGEN UPTAKE .

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Introduction. Endurance exercise improves cardiac performance and affords protection against cardiovascular diseases but the signalling events that mediate these benefits are largely unknown. Phosphorylation is an important and widely studied post-translational modification involved in intracellular signalling pathways. To discover novel signalling events associated with acute exercise we have profiled changes in the cardiac phosphoproteome in response to a graded exercise test of peak oxygen uptake (VO<sub>2</sub>peak). Methods. Male Wistar rats ( $346 \pm 18$  g) were assigned to 3 independent groups (n= 6, in each): control, 0 h and 3 h. All rats were familiarised with the motorised treadmill and metabolic chamber then animals assigned to the 0 h and 3 h groups performed a graded exercise test (Burniston 2009) to measure their VO<sub>2</sub>peak. Groups of animals were killed either immediately (0 h) after or 3 h after completing the exercise test. Control rats were killed at the same time of day as the exercised animals, to minimise the influence of circadian differences. Cardiac homogenates were digested with trypsin and phosphopeptides were enriched by selective binding to titanium dioxide (TiO<sub>2</sub>). Phosphopeptides were analysed by liquid chromatography and high-resolution tandem mass spectrometry. Phosphopeptides were quantified by spectral counting and identified against the UniProt knowledgebase using MaxQuant (v1.3.0.5). Results. The average VO<sub>2</sub>peak of rats in the 0 h and 3 h groups was  $66 \pm 5$  ml•kg<sup>-1</sup>•min<sup>-1</sup> and  $69.8 \pm 5$  ml•kg<sup>-1</sup>•min<sup>-1</sup>, respectively. Proteome profiling detected 1169 phosphopeptides and one-way ANOVA found 149 peptide differences at  $P < 0.05$  with a false discovery rate of 10 %. The significantly regulated phosphopeptides mapped to 105 cardiac proteins and 38 of these have perviously been reported as phosphopeptides, for example S232 & S239 of pyruvate dehydrogenase E1 component subunit alpha, S23 of cardiac troponin I, S16 of phospholamban, S15 heat shock protein beta-1, S59 alpha B-crystallin, Y182 of p38 MAPK and S83 of the cAMP-dependent protein kinase 1-alpha regulatory subunit. Discussion. Some of the phosphoproteins identified have known roles in myocardial contractility and protection against cardiac disease. The majority of phosphoproteins that were differentially regulated in the hours after a standardised bout of endurance exercise were novel discoveries. Therefore, this work provides a rich source of new information to understand the cardiac benefits of exercise. Burniston JG (2009) Adaptation of the rat cardiac proteome in response to intensity-controlled endurance exercise, *Proteomics*, 9: 106-15.

### THE EFFECT OF AEROBIC, ANAEROBIC AND COMBINED TRAINING ON BLOOD IRON, TIBC AND TS OF ELITE WRESTLERS

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THE EFFECT OF AEROBIC, ANAEROBIC AND COMBINED TRAINING ON BLOOD IRON, TIBC AND TS OF ELITE WRESTLERS Gahreman, D.E.1, Mahmoodi, S.A.2, Mahdian, H.3, Javadi Ashrafi, F.2 1: CDU (Darwin, Australia), 2: MAZUMS (Sari, Iran), 3: IAU (Sari, Iran) Introduction Reduced level of iron may comprise athletes' performance by reducing total oxygen carrying capacity of blood. In wrestling, like many other sports, both anaerobic and aerobic energy pathways are employed (Callan et al.,2000) and therefore wrestlers are required to train both energy systems during conditioning phase. Therefore, the aim of this study was to investigate the acute effect of aerobic, anaerobic

and combined aerobic and anaerobic training session on Iron, Total Iron Binding Capacity (TIBC) and Transferrin Saturation (TS) of elite freestyle wrestlers. Methods Twenty four elite male wrestlers were randomly divided into aerobic, anaerobic and combined aerobic and aerobic groups. Aerobic training was consisted of 35 minutes running with 60% of HRmax while anaerobic training consisted of 20 stations where each athlete completed 15 seconds of intense exercise at minimum 80% of HRmax followed by 15 seconds active recovery between stations. The combined group completed both aerobic and anaerobic training in one session. Blood samples were collected before, immediately after training, 3 hours and 24 hours after training session. Blood iron and TIBC level were measured using enzyme-linked immunosorbent assay (ELISA). A mixed model ANOVA was used to investigate the effect of different training protocols on iron, TIBC and TS. Results A significant main effect for time was observed  $F(3, 63)=8.175, p=.000$ , partial eta squared = .280 with blood iron level 24 hours after training ( $M=108.75, SD=29.95$ ) being lower than before training ( $M=117.62, SD=32.91$ ) and immediately after training ( $M=117.66, SD=34.81$ ). There was also a significant main effect for time  $F(3, 63)=6.730, p=.001$ , partial eta squared = .243 with blood transferrin saturation 24 hours after training ( $M=31.73, SD=9.20$ ) being lower than before training ( $M=34.55, SD=10.30$ ) and immediately after training ( $M=34.98, SD=11.09$ ). There was no significant main effect for time, training type or interaction of time and training type on TIBC. Discussion Mechanical stress and profuse sweating during physical activity may result in significant reduction of iron level amongst elite wrestlers up to 24 hours after each training session. Compromised iron level may affect athletic performance as well as general health including immune function, cognitive development and ability to thermoregulate (Weaver and Rajaram,1992). It is advisable to meet RDI for iron and allow adequate recovery between training sessions. References Callan S D, Brunner D M, Devolve K L, Mulligan S E, Hesson J, Wilber R L, Kearney J T. (2000). *Journal of Strength and Conditioning Research*, 14(2), 162-169. Weaver C M, Rajaram S. (1992). *J Nutr*, 122(3 Suppl), 782-787. Contact d.ghareman@gmail.com

### EFFECTS OF HABITUAL JOGGING EXERCISE ON GENE EXPRESSIONS IN MIDDLE-AGED HUMAN SKELETAL MUSCLE

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Introduction The molecular mechanisms leading to prevention of metabolic diseases during habitual jogging are unknown. We examined effects of habitual jogging on gene expressions using DNA microarray analysis. Methods The study consisted of ten Japanese females (age range 55-60 years old). Six females had jogging habit (2-3 hours/week for three years) and four females had no habitual jogging or other exercise. We performed biopsies from vastus lateralis muscle after 24 hour resting condition. We extracted total RNA from frozen muscle and examined gene expressions using microarray. Results A total of 85 differentially expressed genes were identified (fold change  $> \pm 3, P < 0.05$ ) between jogging and non-jogging group. Upregulated genes in jogging groups were BDNF, VEGF, FGF11, and LIF, and downregulated genes were myostatin and BMP3. Genespring pathway analysis revealed that pathways of 1) adipogenesis, 2) BDNF signaling, 3) focal adhesion, and 4) striated muscle contraction were listed in the upregulated transcripts, and pathways of 1) Wnt signaling and 2) neural crest differentiation were listed in the downregulated transcripts. Discussion The present study suggests that multiple pathways related to genes expressions of myokines at resting condition. Additional studies are needed to clarify the relationship between myokine expression and terms of exercise.

### Motor Learning

#### THE QUIET EYE TRAINING IN THE AIMING MOTOR SKILL: INFLUENCE ON MOVEMENT PREPARATION

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The Quiet Eye training in the aiming motor skill: influence on movement preparation Introduction The aiming motor skill is the most fundamental skill while playing sport. Vickers (1996) reported that the accuracy would be improved by acquiring the Quiet Eye (QE). However the relationship between the improvement of the accuracy and the acquisition of the QE is still unknown even though several hypotheses have been proposed. Therefore the purpose of the present study was to investigate how the QE works for improving the accuracy of the aiming motor skill by measuring Movement-related cortical potentials (MRCP) whose participants acquired a distinctive feature of QE through the QE training. Methods Nine male college students ( $23.7 \pm 0.67$  years; mean  $\pm$ SD) who are all right handed participated voluntarily in this study. They had no visual limitation with either little or no experience of playing darts. All participants threw 100 darts before and after the QE training as pre- and post-tests. The QE training was composed of 900 darts throws within 3 weeks but limited 100 darts throws per day. Results All participants improved the skill of throwing dart and increased the QE duration after the completion of QE training. Moreover, it showed that the amplitude of MRCP components for the long QE duration tended to be smaller than the one for the short QE duration. Discussion The results of the study that were the improvement of throwing skill as well as the increase of QE duration were similar to the previous studies (Moore et al., 2012). Regarding MRCP, the amplitude of MRCP components for the long QE duration was smaller than the one for the short QE duration. The activity of brain decreased while the elite of shooting sports was aiming a shot by comparing with the novice (Haufler et al., 2000). Therefore it is conceivable that the amplitude of MRCP components become smaller due to the acquisition of QE in the study. Through the study, it was shown that the QE might contribute to the efficient activity of brain cortex that works for the construction of motor programming. References Haufler, A. J., Spalding, T. W., Santa Maria, D. L., and Hatfield, B. D. (2000) Neuro-cognitive activity during a self-paced visuospatial task: comparative EEG profiles in marksmen and novice shooters. *Biol Psychol*, 53 (2): 131-160. Moore, L. J., Vine, S. J., Cooke, A., Ring, C., and Wilson, M. R. (2012) Quiet eye training expedites motor learning and aids performance under heightened anxiety: the roles of response programming and external attention. *Psychophysiology*, 49 (7): 1005-1015. Vickers, J. N. (1996) Visual control when aiming at a far target. *J Exp Psychol Hum Percept Perform*, 2: 324-354.

#### EEG BRAIN ACTIVITY IN DIFFERENTIAL, CONTEXTUAL INTERFERENCE, AND CLASSICAL REPETITION ORIENTED BADMINTON SERVE TRAINING

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Introduction Several studies demonstrate higher learning rates in differential compared to classical repetition oriented training (e.g. Schöllhorn, Hegen, & Davids, 2012), and contextual interference training (Hegen, Kuby, Horst, & Schöllhorn, 2014). To our knowledge, little

is known on the underlying neuronal processes comparing differential and contextual interference training. In the present study, we compared effects of differential, contextual interference, and classical repetition oriented badminton serve training on EEG brain activation patterns. Methods Eight semi-professional badminton players performed differential, contextual interference, and traditional badminton serve training in a within-subjects design. Electroencephalographic activity was recorded from nineteen electrodes according to the 10-20 system before, and immediately after each 20-minute exercise. Analyses of variance were performed for the EEG data of power density for the theta (4-7.5 Hz), alpha (8-13 Hz), beta (13-30 Hz), and gamma (30-70 Hz) band. Results Increased theta and alpha activity was obtained in contralateral parietal and occipital regions in the differential compared to the classical training condition. After contextual interference training, increased theta activity was found in the contralateral somatosensory area P3. Beta activity was increased in the classical training condition in prefrontal areas. Discussion Results indicate different underlying neuronal processes in differential, contextual interference, and classical repetition oriented training with a higher involvement of parietooccipital areas in differential training, contralateral parietal areas in contextual interference training, and frontal areas in repetition oriented training. Our results suggest that differential training stimulates the visual and somatosensory system, and therefore engages due to its specific characteristics more regions of the cortex, whereas contextual interference training activates specifically the contralateral somatosensory brain area. Repetition oriented training seems to rely on a rather executive controlled processing. References Hegen, P., Kuby, M., Horst, F., & Schöllhorn, W.I. (2014). Contextual interference and differential learning compared in a grip-force-reproduction task. In A. De Haan, C.J. De Ruiter & E. Tsolakidis (Eds.) Book of Abstract of the 19th Annual Congress of the European College of Sport Science – 2nd – 5th July 2014, Amsterdam. Utrecht: Digital Printing Partners. Schöllhorn, W.I., Hegen, P., & Davids, K. (2012). The Nonlinear Nature of Learning - A Differential Learning Approach. *The Open Sport Science Journal*, 5, 100-112.

### PERCEPTUAL TRAINING EFFECTS ON ANTICIPATION OF DIRECT AND DECEPTIVE 7-METER THROWS IN HANDBALL

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This research investigated the effects of video-based perceptual training on the performance of handball goalkeepers when anticipating the directions of both direct and deceptive 7-meter throws (i.e., penalty throws). Forty two Kuwaiti handball goalkeepers voluntarily participated in this study and were randomly assigned to 3 matched-ability groups based on their pre-test performance: participants in the perceptual training group received video-based perceptual training over 7 consecutive days; participants in the placebo training group received video-based regular training; and participants in the control group received no training. The primary findings demonstrated that video-based perceptual training significantly improved anticipatory performances from pre- to post-test under both throwing conditions (i.e., direct and deceptive). Although perceptual training significantly improved anticipation of direct and deceptive throws, anticipation of deceptive throws showed less improvement. The current findings support the first research hypothesis that perceptual training group would improve their anticipation under both throwing conditions more than placebo training and control groups. The findings also support the second research hypothesis that anticipation of deceptive 7-m throws would show less improvement compared to anticipation of direct throws. In conclusion, this study confirms the importance of perceptual training for anticipation skills in sport and adds to the literature that perceptual training can also improve anticipation of deceptive actions. In addition, this study confirms that deception in handball is a challenging task that goalkeepers can minimize, but cannot eliminate, its effect by enhancing their perceptual skills.

### SPORT AND IMAGINATION IN YOUNG SCHOOL ATHLETES WHO COMPETED IN KÜTAHYA

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Introduction The most academic study about preparation for compete, emphasizes that mental preparation is important such as physically preparation. (Gallego, DenotLedunois, Vardon, & Perruchet, 1996; Heath & Gonzalez, 1995; Kuhling, 1989). When thought this situation, In this study, purposed that young school athletes of imagination in sport levels. Methods This study is a descriptive study. In this study, as measuring tool, The Sport Imaginary Questionnaire was used which translated and converted by Kafkas (KAFKAS, 2011). Sampling was created by primary and secondary 420 students who participated in Kütahya inter school races. Independent simple t-test and One-Way ANOVA tests was used as statistical methos. Significantly level was accepted as  $p < 0,05$ . Results At the end of this study, According to gender, The items of "I would imagine that others tell me I did a good job." ( $t_{.05} = 2,077$ ;  $p < 0,05$ ), "I imagine that I kept my cool competitions." ( $t_{.05} = 2,252$ ;  $p < 0,05$ ), "I imagine wanting amazing attention as a lost case control." ( $t_{.05} = 2,261$ ;  $p < 0,05$ ), "I imagine myself to be reached with the successful outcome of a difficult situation." ( $t_{.05} = 2,316$ ;  $p < 0,05$ ), was seen significantly different. According to species of sport (team or individual), The items of "I would imagine that others tell me I did a good job." ( $t_{.05} = -2,021$ ;  $p < 0,05$ ), "I would imagine that the audience cheering for me." ( $t_{.05} = -2,507$ ;  $p < 0,05$ ), "I imagine myself as a champion." ( $t_{.05} = -2,179$ ;  $p < 0,05$ ), "Before the competition in my mind I imagine how cool I am." ( $t_{.05} = -2,211$ ;  $p < 0,05$ ), "I can imagine how it would be exciting to be in a competition." ( $t_{.05} = -1,985$ ;  $p < 0,05$ ), "I imagine myself as collected in a difficult situation to my attention." ( $t_{.05} = -2,104$ ;  $p < 0,05$ ), "I imagine wanting amazing attention as a lost case control." ( $t_{.05} = -2,881$ ;  $p < 0,05$ ), "I imagine myself to be reached with the successful outcome of a difficult situation." ( $t_{.05} = -2,577$ ;  $p < 0,05$ ) was seen significantly different. Discussion When seen in this findings. Gender differencies can be looked as important factor for imagination in sport. However coaches must be think attentionally about technics and compete for gender. Other important factor for imagination in gender; was seen sport species. Imagination is very important but coaches must be wide awake about instruction. Wrong thought can be resulted unwanted situation. References Gallego, J., DenotLedunois, S., Vardon, G., & Perruchet, P. (1996). Ventilatory responses to imagined exercise. *Psychophysiology*, 33(6), 711-719. doi: DOI 10.1111/j.1469-8986.1996.tb02367.x KAFKAS, M. E. (2011). ÇOCUKLAR İÇİN SPORDA HAYAL ETME ÖLÇEĞİNİN TÜRKÇEYE UYARLANMASI: BİR GEÇERLİK VE GÜVENİRLİK ÇALIŞMASI. *Niğde Üniversitesi Beden Eğitimi Ve Spor Bilimleri Dergisi*, 5(2), 101-109. Kuhling, A. (1989). Strength and Imagination - the Making of Heroes in Sports - German - Gebauer, G. *Argument*, 31(1), 132-133.

## Neuromuscular Physiology

### ECCENTRIC, BUT NOT CONCENTRIC PEAK TORQUE IS RELATED WITH COUNTERMOVEMENT JUMP PERFORMANCE IN HIGH LEVEL POWER ATHLETES

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**Introduction** Both eccentric and concentric muscle force are considered important for maximizing countermovement jump height (Lafayette et al., 2014). A recent study showed that peak isokinetic knee extension torque was the single significant predictor of CMJ, while the relationship was increased with increasing angular velocity (Yapici et al., 2014). However, in the same paper, a significant indicator of CMJ was found to be the eccentric quadriceps peak torque. The purpose of the present study was to examine the relative importance of isokinetic . **Methods** Nine high level athletes (age: 27.6±4.6 yrs, height: 184±6 cm, body mass: 82±8 kg, body fat: 8.5±3.2%) took part in the study. Isokinetic dynamometry (Kin Com) was used to measure peak torque during maximal concentric knee extension/flexion at angular velocities of 60 and 180 degrees per second. Eccentric peak torque of the knee extensors was also measured at an angular velocity of 60 degrees per second. Countermovement jump was measured using a contact mat. Torque data were compared using two-way ANOVA with repeated measurements (leg x angular velocity). Relationships between variables were assessed using Pearson product-moment correlation ( $p < 0.05$ ). **Results** There was no significant difference between the two legs in all peak torque values. Peak concentric knee extension torque at 60 and 180°/s were 245±31 and 171±22 Nm, while the corresponding flexion peak torques were 151±30 and 118±25 Nm. Peak eccentric knee extension torque was 357±39 Nm or 4.36±0.46 Nm/kg body mass (146±13% of concentric extension peak torque at 60°/s). CMJ height was 44.0±3.4 cm. Low and non-significant correlations were found between absolute knee extension and flexion peak torques and CMJ ( $r < 0.40$ , ns). When peak torque values were expressed per kg body mass, the correlations between CMJ height and concentric extension and flexion peak torque increased, but did not reach significance ( $r = 0.40$  to 0.51, ns). However, the correlation between CMJ height and eccentric knee extension peak torque was high ( $r = 0.80$ ,  $p < 0.01$ ). **Discussion** The results of the present study showed that eccentric knee extensor peak torque is related with CMJ height and thus confirm the notion that eccentric strength is more important than concentric in terms of jumping performance. Coaches are advised to increase eccentric strength when the aim is to improve CMJ. **References** Laffaye G1, Wagner PP, Tombleson TI (2014). *J Strength Cond Res.* 28(4), 1096-1105 Yapici A, Findikoglu G, Dundar U (2014). *J Sports Med Phys Fitness.* PMID: 25410575 Contact gbogdanis@phed.uoa.gr

### DOMINANT VS NON-DOMINANT ARM EMG ACTIVITY DURING MENTALLY SIMULATED ISOMETRIC HAND CONTRACTIONS IN RIGHT HANDERS

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**Introduction** Laterality is an important feature of motor behavior. Several studies have shown that lateralization in right-handed young adults (i.e., right versus left arm superiority) emerges also during imagined actions, that is when an action is internally simulated without any motor output (Paizis et al. 2014). In the present study, we investigated whether right-handers can generate EMG activity during motor imagery with their right or left arm. With this aim, subjects carried out imagined isometric hand muscle contractions (Lebon et al. 2008) for different level of intensity. **Methods** Twelve right-handed males (mean age: 23.7 • 4.4 years) held the grip strength of a dynamometer, either with their dominant right hand or with their non-dominant left hand, and carried out 3 tasks. In the actual grip task, they were requested to develop, grip forces at 4 intensities: 25%, 50%, 75%, or 100%. Maximum grip strength was previously calculated on the basis of 3 trials. In the imagined grip task, participants imagined performing the 4 specific intensities. In the rest task, participants kept their arms relaxed on the table for 5s. We evaluated the level of muscle activation during actual and mental contractions by recording EMG signals from the Flexor Carpi Radialis (FCR) and Extensor Carpi Radialis, (ECR) muscles. **Results** We found that MI was accompanied by a subliminal specific EMG activity of agonist muscles, but also that of antagonist, fixator muscles. Further, the results revealed a greater EMG activity during MI than during the rest condition, whatever the muscle of right or left arm. The ECR muscle for Dominant and Non Dominant arm shows similar patterns EMG activity. On the other side, we found a different effect of intensity contraction during MI for the FCR for the Dominant than the Non Dominant arm. We observed similar levels of EMG subliminal activities for different levels of intensity contraction for the Non-Dominant arm that for the Dominant arm (only à 100%). **Discussion** These findings suggest difference in motor output between the dominant and the non-dominant arm during imagined actions concerning grip strength task and flexor muscles in the right handers. **References** Paizis C, Skoura X, Personnier P, Papaxanthis C. (2014). *Motor Asymmetry Attenuation in Older Adults during Imagined Arm Movements.* *Front Aging Neurosci.* Mar 20;6:49. doi: 10.3389/fnagi.2014.00049. eCollection 2014. Lebon F, Rouffet D, Collet C, Guillot A. (2008). *Modulation of EMG power spectrum frequency during motor imagery.* *Neurosci Lett.* Apr 25;435(3):181-5. doi: 10.1016/j.neulet.2008.02.033. Epub 2008 Mar 10. Contact christos.paizis@u-bourgogne.fr.

### ACTIVATION PATTERNS AND CO-ACTIVATION OF SHANK MUSCLES IN YOUNG CHILDREN AND ACTIVE SENIORS BEFORE AND AFTER A SLACKLINE BALANCE TRAINING INTERVENTION

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**Introduction** Children' and seniors' show comparable fall incidence rates. However, studies examining the relative muscle activation and co-activation of shank muscles are rare. The aim of this study was therefore to examine the contribution of selected ankle muscles to single leg standing (SLS) and co-activation during maximum voluntary contraction (MVC) before and after a supervised slackline balance training intervention in different age-groups. **Methods** Twenty-six active and healthy seniors (age: 62.9 (SD 6.3)) and 17 young children (age: 9.7 (0.5)) were assigned to either an intervention (INT) or control (CON) group. INT performed supervised and gradually increased slackline balance training for six weeks on Gibbon Slackracks (ID Sports, Stuttgart). Before (Pre) and after (Post) the intervention, all participants performed SLS while standing on stable ground for 30 seconds and MVC on their dominant leg (i.e. limb preferred to kick a ball). Surface EMG (Imago, Freiburg) data of selected ankle muscles (tibialis anterior, TA; medial head of gastrocnemius, MG; soleus, SO) was used to characterize relative muscle activity contributions (percent of cumulative muscle activity) of every measured muscle during SLS. The amount of co-activity of the antagonist muscle (TA, SO) was determined using the value reached by the antagonist during the agonist MVC activation over the MVC value during its own agonist task (Maganaris et al. 1998). Differences were verified with repeated measures



analyses of variance. Additionally, effect sizes (partial eta squared,  $\eta^2$ ) were calculated. Pairwise comparisons were performed using Student's t test. Results Baseline comparisons showed significant main effects for age-group for muscle activity contributions of TA and SO ( $P < 0.01$ ; children: TA 18% (9), mean (SD); SO 39% (10), seniors: TA 30% (14), SO 24% (9)) during SLS and co-activity ( $P < 0.05$ ) during MVC. No time interaction effects were found for co-activity and relative contributions ( $P > 0.05$ ). Age-group independent analyses, however, revealed a significant intervention effect for co-activity of SO ( $P = 0.012$ ,  $\eta^2 = 0.24$ ) in seniors only. The post hoc analysis showed a significant reduction of SO co-activity in INT ( $P < 0.01$ ; Pre 49% (28), Post 33% (17)) but not in CON. Discussion Compared to young children, healthy seniors showed inversed ankle coordination patterns during SLS. This finding may point towards different postural strategies in both age-groups, which remain unaltered even after demanding balance interventions. Additionally performed calf muscle strength training might support balance training adaptations in seniors. References Maganaris et al. (1998). *Exp Physiol*, 83, 843-855. Contact [eduard.kurz@unibas.ch](mailto:eduard.kurz@unibas.ch)

### EFFECTS OF DEPTH IN COLD WATER IMMERSION ON RECOVERY FROM PLYOMETRIC EXERCISE-INDUCED MUSCLE DAMAGE

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**Introduction** Cold water immersion (CWI) is one of the popular interventions to facilitate recovery from fatigue and/or exercise-induced muscle damage (EIMD). It has been reported that water immersion depth, hence the area of hydrostatic pressure to the body, is a factor affecting the effect of CWI on recovery from EIMD [1]. Although a recent study compared two different positions (i.e. seated and standing) of CWI to the waist level on recovery from EIMD [2], no previous study has compared the effect of CWI to the waist and chest at the same position such as sitting. The present study compared two different cold water immersion depths for their effect on recovery from plyometric exercise-induced muscle damage to the lower limbs. **Methods** Twenty four untrained men (age:  $23.6 \pm 1.2$  y, high:  $172.2 \pm 4.7$  cm, weight:  $68 \pm 7.3$  kg) performed 5 sets of 20 drop jumps from a high of 0.6 m box with 2 min rest between sets. The exercise was followed by either passive recovery (CON, n=8), CWI to the waist (CWI-W, n=8), or CWI to the chest (CWI-C, n=8) for 15 min at  $14^\circ\text{C}$  immediately and every 24 hours for 3 days after exercise. Maximal voluntary isometric contraction (MVC) torque, upper thigh circumference (CIR), muscle soreness (SOR) and counter movement jump (CMJ) height were measured before, immediately and 1-4 days after exercise from non-dominant leg. Changes in these variables after exercise were compared between the groups by two-way repeated measures ANOVA. **Results** Significant changes in MVC torque (CON: 19-36%, CWI-W: 22-38%, CWI-C: 21-37% decrease from immediately to 3 days post-exercise), CIR (CON: 3-18 mm, CWI-W: 3-11 mm, CWI-C: 4-14 mm increase), SOR (CON: 10-41 mm, CWI-W: 6-48 mm, CWI-C: 3-41 mm increase in a 100-m visual analog scale) and CMJ height (CON: 11-20%, CWI-W: 6-20%, CWI-C: 10-19% decrease) were evident ( $P < 0.05$ ) after exercise. At 3 days post-exercise, MVC, SOR and CMJ were still significantly different from the baseline values. There were no significant differences between CON, CWI-W and CWI-C groups for the changes in any of the variables during the 4-day recovery period. **Discussion** These results show that changes in indirect muscle damage markers after plyometric exercise were not modified by CWI regardless of the water depth, although some of the muscle damage markers did not return to the baseline values at 3 days post-exercise. It is concluded that the CWI protocols used in the present study did not affect the time course of recovery from EIMD, and the depth of CWI had little effect on the recovery. **References** 1) Vaile et al. (2008) *EJAP*, 102, 447-55. 2) Leeder et al. (2015) *JSS*, 9, 1-9.

### REPEATED PAIRING OF STRETCH REFLEX AND TRANSCRANIAL MAGNETIC STIMULATION TO INDUCE MOTOR CORTEX PLASTICITY

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**INTRODUCTION** Paired associative stimulation (PAS) is a non-invasive stimulation method developed to induce long-term potentiation (LTP)- and long-term depression (LTD)-like plasticity at the target synapse. PAS combines electrical stimulation of a peripheral nerve with transcranial magnetic stimulation (TMS) over motor cortex. The change in the excitability has also been related with behavioral changes. However, considerable inter-individual variability of PAS-induced effects has been reported. This wide variability has been associated e.g. with differences in functional brain areas (Ridding and Ziemann 2010). Thus, the purpose of this study was to modify the traditional PAS in order to reduce this inconsistency. In the modified PAS (PASreflex), the synchronous electrical stimulation of Ia afferents was replaced by a more asynchronous burst like activity induced by natural fast muscle stretch. **METHODS** Subjects sat on an ankle dynamometer with their right foot resting on a pedal. Motor cortex excitability was assessed by TMS to measure input-output curve (IO-curve) of resting soleus motor-evoked potentials (MEPs) before, immediately after and 30 min after the interventions. PASreflex (14 subjects) consisted of soleus stretch reflex elicited with a perturbation induced by the ankle dynamometer and a single TMS pulse, which were paired 200 times to induce LTP-like plasticity. The intervention of the control group (PAScont; 9 subjects) included only the stretch reflex. **RESULTS** In the PASreflex group the slope of the IO-curve decreased non-significantly at post0 and increased significantly at post30. There was a significant difference between the post0 and post30 measurements. Mean MEP amplitudes increased significantly by  $36 \pm 86\%$  at post30. There were 9 responders out of 14 subjects at post30. There were no changes in slopes or mean MEPs in the PAScont group. **DISCUSSION** It was interesting that PASreflex modulated cortical excitability differently immediately after and 30 min after the intervention. It is most likely, that due to the nature of the stretch reflex, a number of different intracortical tracts can be operative. Thus, stretch reflex might have activated several sets of interneurons in the motor cortex, which then could have interfered with each other by homosynaptic and heterosynaptic modifications leading to both LTP- and LTD-like after-effects. Unfortunately, the variability did not decrease after PASreflex since there were 9 responders out of 14 subjects at post30, which is about the same as has been reported for traditional PAS. **REFERENCES** Ridding MC, Ziemann U. (2010). *J.Physiol.* 588:2291-2304. **CONTACT** Susanne.kumpulainen@jyu.fi

### EFFECTS OF COLD-WATER IMMERSION CRYOTHERAPY $<15^\circ\text{C}>$ ON VERTICAL JUMP PERFORMANCE AFTER EXERCISE-INDUCED MUSCLE DAMAGE

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**INTRODUCTION:** Athletes and physically active people can decline strength and height of vertical jump when associated to unaccustomed strenuous exercise (Leeder et al., 2012) (eccentric actions such as vertical jump), causing exercise-induced muscle damage. The cold-

water immersion (CWI) has been widely recommended to fasten the recovery period from muscle damage by exercise scientists and athletic trainers. However, ideal temperature and time of stay in water for optimal muscle damage recovery is conflicted (Bleakley et al., 2010). It is important to evaluate the vertical jump as functional movement possible to identify changes in vertical jump height caused by training, injuries resulting from this or not (Nuzzo et al., 2011). Therefore, the aim of this study was to evaluate the effects of one only session of CWI at 15°C in 20 min. on vertical jump performance recovery after the exercise-induced muscle damage. **METHODS:** 23 physically active men (20±2,16years; 70±8,21kg; 175±6,96cm; 12±6,47%BF) completed five sets of 20 drop jumps with 2 min of rest interval between sets. The exercise drop jump consisted of landing on the floor from a 60 cm box and jump immediately upward maximally. After exercise, participants were randomly assigned to two groups: 1) CWI during 20 min at 15°C (n=12) and 2) Control (n=11). Vertical jump performance, in height (cm) was measured in force plate (BP400600, AMTI, Watertown, MA, USA) at baseline and 24, 48, 72, 96 and 168 hours after exercise. **RESULTS:** There was no significant difference between intervention and time on vertical jump height for both groups ( $F = 1.370$ ,  $p = 0.71$ ). The greater vertical jump height decrement ( $44±4.93$ cm to  $38±6.44$ ) was observed 24 hours and returned to baseline value at 168 hours ( $p>0,05$ ) after exercise for both groups. **DISCUSSION:** The results from the present study demonstrated that CWI at 15°C do not provide any additional muscle recovery of vertical jump performance on compared with passive control. Further studies should investigate underlying mechanisms of major variables of the vertical jump and other movements of reactive strength. **REFERENCES:** Bleakley, C.M. and G.W. Davison, What is the biochemical and physiological rationale for using cold-water immersion in sports recovery? A systematic review. *Br J Sports Med*, 2010. 44(3): p. 179-87. Leeder, J., et al., Cold water immersion and recovery from strenuous exercise: a meta-analysis. *Br J Sports Med*, 2012. 46(4): p. 233-40. James L. Nuzzo, Jonathan H. Anning and Jessica M. Scharfenberg. The reliability of three devices used for measuring vertical jump height. *Journal of Strength and Conditioning Research / National Strength and Conditioning Association*, 2011. 25(9): p. 2580–2590. CONTACT: mateus.silva.bezerra@hotmail.com

### THE INFLUENCE OF FILTER TECHNIQUE ON QUADRICEPS ELECTROMYOGRAPHY DATA RECORDED DURING WHOLE BODY VIBRATION

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**Introduction** The use of surface electromyography (sEMG) measurements during whole body vibration (WBV) allows potential individualised responses to WBV frequency to be recorded but is problematic due to electromagnetic noise recorded by sEMG. As yet the effect of different filtering techniques on sEMG data collected during WBV is relatively unknown and whether portions of muscle sEMG data are removed post filter application. Therefore, the objective of this study was to investigate the effect of filter techniques on quadriceps EMG data collected during WBV in trained participants. **Methods** Three filtering techniques (Unfiltered; Filter 1; Filter 2) were individually applied to identical sEMG quadriceps data sets, collected during WBV of varying frequencies (30; 35; 40; and 50Hz). The filter techniques consisted of: Unfiltered, no digital filter; Filter 1, a 14th Order Butterworth band pass filter (20 – 300Hz, passband 3dB, attenuation 40dB); Filter 2, the same band pass filter with a series of 14th Order Butterworth notch filters (band stop  $\pm 1.5$  Hz centred at WBV fundamental frequency and relevant sub-harmonics). The sEMG data was then root mean squared (sEMGrms). Filter 2 was then applied to 'clean' sEMGrms data recorded during 0Hz. Statistical analysis included a 2-way repeated measures ANOVA (filter [unfiltered, filter 1, filter 2] x frequency [30, 35, 40, 50 Hz]). Finally, Pearson's correlation coefficients ( $r^2$ ) were calculated following the three filters for all WBV frequencies. Results Presence of motion artifacts at fundamental and subsequent sub harmonics frequencies were confirmed via power spectral density. Significant main effects for filter were found with significant differences between all filter techniques. No main effects were found for filter 2 when applied to 'clean' sEMGrms data. **Discussion** Significant portions of sEMGrms data signal were removed depending on the type of filter technique (Filter 2 > Filter 1 > Unfiltered). Applying notch type filters may not remove significant portions of muscle activity signal. These results indicated that even though notch filtering may remove significant portions of sEMGrms signal, it appears that it is not muscle signal. This supports previous research Fratini et al. (2009) in that inclusion of motion artifacts within EMG data recorded during WBV may lead to over estimation of muscle activity. However, the data conflicts with Ritzmann et al. (2010) who reported minimal influence of motion artifacts. This highlights the discrepancies within WBV research due to differences in WBV platforms and parameters. Further research investigating the effect of filter techniques across WBV characteristics is required. **References** Fratini, A., Cesarelli, M., Bifulco, P. & Romano, M. (2009). *J Electromyogr Kinesiol* 19, 710-718. Ritzmann, R., Kramer, A., Gruber, M., Gollhofer, A. & Taube, W. (2010). *Eur J Appl Physiol* 110, 143-151. Contact Mark.Sanderson@uws.ac.uk

### REPRODUCIBILITY OF CORTICAL VOLUNTARY ACTIVATION LEVEL ON TIBIALIS ANTERIOR MUSCLE

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**Reproducibility of cortical voluntary activation level on tibialis anterior muscle** 1 Souron, R., 1 Farabet, A., 2 Millet, G., 1 Lapole, T. 1 Laboratoire de Physiologie de l'Exercice, Université de Lyon, Saint-Etienne, France 2 Human Performance Laboratory, University of Calgary, Calgary, Canada **Introduction** It is clearly established that training induces several nervous adaptations leading, in fine, to an augmentation of the maximal voluntary contraction (MVC). One potential mechanism is the enhancement of the descending motor command at a cortical level (Goodall and al., 2014). The assessment of the cortical voluntary activation level (VA) is now possible with the transcranial magnetic stimulation (TMS) technique. If these measurements were already reported to be reliable on the elbow flexor muscles (Todd and al., 2003) and the quadriceps muscle (Goodall and al., 2009), the reproducibility of VA on the tibialis anterior muscle remains to be determined. The present study aim to assess the inter-session reproducibility of the cortical voluntary activation. **Methods** The motor cortex of the right leg area was stimulated with a double 110mm cone coil. The optimal was determined and marked before each visit. The optimal intensity of magnetic stimulation was determined using a recruitment curve, at a 20%MVC level of contraction. This intensity corresponded to the intensity eliciting a maximal motor evoked potential on the tibialis anterior muscle and a maximal amplitude of the superimposed twitch (SIT) (i.e. the increased in muscle force). Voluntary activation was then assessed during MVC using this formula:  $VA = (1 - |SIT/ERT|) \times 100$  with ERT, the estimated resting twitch determined by linear regression of the relation between SIT amplitude and voluntary force at 100, 75 and 50% MVC. VA was measured on two separate days on 13 subjects in order to assess intra-session reproducibility, characterized by the intra-class correlation coefficient (ICC), standard error in measurement (SEM) and coefficient of variation (CV). Results VA presented an excellent reproducibility with 0.99 ICC, 0.8% CV and 0.5% SEM. **Discussion** VA of the tibialis anterior is highly reproducible as previously reported for other muscles groups (Todd and al., 2003; Goodall and al., 2009). Thus, it can be reliably used to investigate the training-induced nervous adaptations at the cortical level. **References** Todd, G., et al. (2003). 'Measurement of voluntary activation of fresh and fatigued human muscles using transcranial magnetic stimulation.' *J Physiol* 551(Pt 2): 661-671. Goodall, S., et al. (2009). 'Voluntary activation of human knee extensors measured using transcranial magnetic stimulation.' *Exp Physiol* 94(9): 995-1004.

Goodall, S., et al. (2014). 'Transcranial magnetic stimulation in sport science: a commentary.' *Eur J Sport Sci* 14 Suppl 1: S332-340. Contact robin.souron@gmail.com

### **HIP AND TRUNK MUSCLE ELECTROMYOGRAPHY DIFFERENCES BETWEEN BILATERAL AND UNILATERAL BODYWEIGHT RESISTANCE EXERCISES**

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**Introduction** In sports, force production and movement are predominantly generated in a unilateral weight-bearing stance. Therefore, unilateral resistance training may possibly elicit more sport-specific strength gains compared to traditional bilateral strength training. Hip- and trunk- muscles stabilize the pelvis and trunk to maintain proper technique and posture in resistance training and are thought to play a central role in sports performance as well as injury prevention. Hip- and trunk- muscle activity increases as the body weight balance change from a bilateral to a unilateral stance. Little research has examined the magnitude of change in muscle activation differences between bilateral and unilateral stance in lower body exercises. **Aim** The aim of this study was to examine the electromyographic (EMG) activity in hip and trunk muscles in three bodyweight exercises performed in a bilateral and a unilateral stance. **Methods** 14 healthy, young adults participated in a single session, single-group, observational study. Manual muscle testing was used to attain a maximal voluntary isometric contraction (MVC) value for gluteus medius, gluteus maximus, rectus abdominis, and erector spinae. EMG measurements (4 channel ME6000, MegaWin Software, Kuopio, Finland) were taken during performance of squat, bridge, and plank exercises in both a bilateral and a unilateral stance. **Results** In all three exercises, EMG activity (presented as magnitude of change) was greater in the unilateral stance compared to the bilateral stance ( $p < 0.05$ ), for the muscles gluteus medius (squat 478%, bridge 204%, plank 285%) and gluteus maximus (squat 371%, bridge 172%, plank 233%). In addition, in plank, EMG activity was greater in unilateral stance compared to the bilateral stance ( $p < 0.05$ ) in rectus abdominis (120%) and erector spinae (127%). In the squat and bridge, no differences were identified in EMG activity for rectus abdominis and erector spinae between the bilateral and the unilateral stance. **Discussion** Nearly all unilateral exercises activated the hip muscles (gluteus medius, gluteus maximus) more than double compared to the same exercises performed bilaterally. In particular, gluteal muscle activity during the unilateral squat was more than 3.5 fold greater as compared to the bilateral stance. This greater magnitude of change in the unilateral squat might be explained by the single contact point with the ground in the squat, whereas the bridge and plank exercises include more ground contact points even in their unilateral stance. A unilateral training program including squat exercises might be beneficial for developing hip strength which is of great importance in sports performance. Contact bjorn.frandsen@hh.se

### **COMPARISON OF THREE PROTOCOLS FOR MEASURING EXERCISE INDUCED MUSCLE SORENESS**

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**Introduction** Delayed-onset muscle soreness (DOMS) has been defined as a form of muscular hyperalgesia and manifests as pain and stiffness in the muscles several hours after strenuous or unaccustomed exercise (Clarkson et al., 1992). Multiple methods exist to assess the perceived soreness, however there are some limitations such as the standardization of the force applied during palpation and the difference of soreness perceived along the length of the muscle (Newham et al., 1983). The aim of this study was to compare different DOMS assessment protocols in their sensitivity to DOMS and other indicators. **Methods** Three different protocols of evaluating DOMS were compared in response to: a) a football match, b) a basketball match, c) a handball match, d) acute eccentric exercise, e) acute plyometric exercise, f) a weight training bout, g) acute intense running. DOMS and performance (vertical jumping, speed, maximal strength) were measured at baseline, 12 hours post-exercise as well as 1, 2, 3 and 4 days of recovery. The protocols of DOMS evaluated perceived soreness in quadriceps femoris by palpation a) in the standing position (STAN), b) in the sitting (SIT) position and c) in the standing position following three repetitions of a squat movement (SQUAT). Participants in these studies were a) both males and females, b) pre-adolescents, adolescents, adults and elderly and c) trained and sedentary. **Results** Data analysis revealed that SQUAT produced higher values than the other two DOMS protocols at 24 (for all exercise modes) and 48 hours (for eccentric exercise and plyometric training) of recovery. This difference was more pronounced in sedentary (vs. trained) and older participants (vs. younger adults and pre-adolescents/adolescents). No differences were noted between males and females. A significantly ( $p < 0.05$ ) higher correlation was observed between changes in SQUAT and performance at 24h and 48h than between changes in STAN and SIT. SQUAT produced higher DOMS values following team sports and running as compared to other exercise modes. **Discussion** The results of this study indicate that DOMS measurement following three squat repetitions may provide a more sensitive measure of muscle damage development following various exercise modes. **References** Clarkson, P.M., Nosaka, K. & Braun, B. (1992). Muscle function after exercise-induced muscle damage and rapid adaptation. *Medicine and Science in Sports and Exercise*. 24 (5). p.pp. 512-520. Newham, D.J., Mills, K.R., Quigley, B.M. & Edwards, R.H. (1983). Pain and fatigue after concentric and eccentric muscle contractions. *Clinical Science (London, England: 1979)*. 64 (1). p.pp. 55-62. Contact georgios.mavropalias@gmail.com

### **LINEAR AND NONLINEAR ASSESSMENTS OF POSTURAL CONTROL**

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Nonlinear analysis (wavelet) has been suggested to better describe motor control mechanism underlying postural sway. **Purpose:** The purpose of this study was to examine relationships between traditional linear measures of postural sway and nonlinear measures of postural sway (wavelet), in order to provide references for optimal description of research in motor control area. **Method:** Six collegiate baseball players and six college students who had never had sport training experience were asked to maintain standing balance with barefoot on forceplate for 10 seconds under the conditions of eyes-open and eyes-closed. **Results:** Linear and nonlinear center of pressure (CoP) calculations reveal that when vision was removed, both groups demonstrated larger postural sway; wavelet observed that the baseball players utilized great sensory information from spinal reflective loop, muscle activity and cerebellar with respect to ordinary in the anterior-posterior direction and from cerebellar and vestibular system in the media-lateral direction. However, linear measures of postural performance reveal that there were no significant relationships between neuromuscular response and subjects who whether have sport training experience. Independent variables from wavelet have more comprehensive explanation to dependent variables.

Conclusion: Detailed description in wavelet may suggest that effectively physiological parameters and more neuromuscular information could be achieved through nonlinear analysis.

### MOVEMENT LATERALIZATION AND BIMANUAL COORDINATION IN TENNIS PLAYERS

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**Introduction.** Tennis is a sport that requires asymmetric movements and mainly involves proximal upper limb muscles. Skilled tennis players learn by training to improve dominant hand performance in terms of precision and strength. However, motor transfer between proximal and distal upper limb muscles has not been studied in tennis players (TP) so far. The aim of our study is to investigate movement lateralization and bimanual coordination of finger opposition movements in TP. **Methods.** 14 TP and 14 healthy controls (HC), matched for age and gender, were recruited for the study. All subjects were right handed. Using a sensor-engineered glove, they were executed the following motor sequence: opposition of thumb to index, medium, ring and little finger. They practiced the task with the right hand and subsequently with both hands. Subjects were asked to tap in synchrony with a metronome cue at 0.5 /2 Hz for 45 s. We evaluated: touch duration (TD; contact time between the thumb and another finger), inter-tapping interval (ITI); time between the end of one tapping and the beginning of the subsequent one), and the percentage of correct movements (SEQC). Kinematic data were analyzed to explore: movement lateralization, comparison of right hand performance on single-hand (RH-S) and bimanual tasks (RH-B), and bimanual coordination, comparison of right- and left-hand performance during the bimanual task. **Results.** On Movement Lateralization, TP showed longer TD, shorter ITI and a larger number of SEQC with respect to HC ( $p < 0.05$ ). No main effects of condition (RH-S vs RH-B) or rate or interactions were found. On bimanual coordination, statistical analysis showed a significant effect of GROUP for TD, ITI and SEQC ( $p < 0.05$ ). TP exhibited longer TD, shorter ITI, and a larger number of SEQC with respect to HC. A significant effect ( $p < 0.05$ ) of HAND for TD, ITI and SEQC was also found. Indeed, in both groups performance of right hand was characterized by shorter TD, longer ITI and a larger number of SEQC with respect to the left hand. **Discussion.** Our results suggest that when TP have to perform finger movements following an external cue, they showed a longer TD, a shorter ITI and a higher number of correct movements with respect to HC. Thus, TP were more accurate, likely thanks to the change of motor strategy adopted (longer TD and shorter ITI). Whereas ITI is likely to represent a pure motor phase, TD may be regarded as the combination of a sensory phase and a motor preparation phase. We can speculate that TP make a more accurate use of sensory information in order to make faster and more accurate the movement time because of training. These findings suggest that a transfer of learning between proximal and distal upper limb muscles has been occurred. Contact: emanuela.faelli@unige.it

### AGE-RELATED MORPHOLOGICAL DEGENERATION OF THE MYELIN SHEATHS AND CAPILLARIES IN THE DISTAL TIBIAL NERVES WITH AGING OF RATS

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**[Purpose]** The atrophy and dysfunction of myelinated fibers with ageing mainly appears with failure of interactions with capillary metabolism. However, it is not morphologically clear whether both the distal sites of peripheral neurons and capillaries degrade with aging. The aim of this study is to investigate morphological changes in the myelinated fibers and capillary architecture of the distal tibial nerve on aging in rats. **[Materials and Methods]** The male Wistar rats aged 20 weeks (young group,  $n = 3$ ) and 90 weeks (elderly group,  $n = 3$ ) were used in this study. The bilateral hindlimbs were perfused by contrast medium solution through the abdominal aorta. From the frozen tibial nerves of several millimeters, serial transverse sections of  $5\mu\text{m}$  thick were sliced with a cryostat microtome (CM3050; Leica Microsystems, Germany) and myelin sheaths were stained with 1 % toluidine blue. Then, transverse sections were visualized with a light microscope. The 3-D capillary architecture in the sample block of tibial nerve was imaged by confocal laser scanning microscopy (TCS-SP; Leica Instruments, Germany) with an argon laser. The myelinated fibers were divided into three fiber types (large, middle and small fibers) according to histogram of the fiber diameter. A two-way ANOVA was performed under three fiber types to compare the myelin sheath thickness, axon diameter and G-ratio (axon diameter/fiber diameter) between the young and elderly groups. An unpaired t-test was used to compare the capillary diameter and the number of microvascular ramifications between the young and elderly groups. **[Results]** Two-way ANOVA revealed there were the main effects in the fiber types ( $p < 0.0001$ ) and groups ( $p < 0.0001$ ), except for G-ratio. The myelin sheath thickness and axon diameter of all fiber types in the elderly group were significantly lower ( $p < 0.01$ ) than that observed in the young group. The capillary diameter and number of microvascular ramifications in the elderly group indicated significant decrease ( $p < 0.01$ ) than the young group. **[Conclusions]** Both the myelinated fibers and capillaries in the distal tibial nerves degrade with aging. The finding of recent studies is that apoptosis and degeneration of old cell were associated with elevated intraneuronal levels of reactive oxygen species. In brief, the increase in oxidative stress may indirectly be responsible for regressions of myelin sheath and capillary. Furthermore, expression levels of vascular endothelial growth factor and brain derived neurotrophic factor that respectively promotes angiogenesis and Schwann cell survival may decrease with aging.

### IS THERE A PREFERENTIAL HYPERTROPHY WITHIN A MUSCLE DUE TO RESISTANCE TRAINING?- A STUDY IN RECTUS FEMORIS AND VASTUS LATERALIS MUSCLES -

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**Introduction:** It has still not been established whether individual muscle hypertrophies to a greater degree at a particular location (proximal, middle, or distal level) due to resistance training (RT). The purposes of this study were to investigate the time course of change in muscle thickness (MT) in different locations of the rectus femoris (RF) and vastus lateralis (VL) during 8 weeks of RT, and to clarify the intramuscular difference in muscle hypertrophy. **Methods:** Eight healthy males ( $23.7 \pm 3.0$  years) performed a RT program on the knee extensors with intensities of 80% 1RM. The subjects completed a program of three days per week for 8 weeks, which consisted of three sets with eight repetitions. MT was assessed as an index of hypertrophy at three anatomical sites (proximal, medial and distal regions) of RF and VL, respectively, using ultrasonography. MT was measured before (pre), and at 4 weeks, 6 weeks and 8 weeks during the RT. Two-way ANOVA with repeated measures (time  $\times$  region) was used to analyze the effects of hypertrophy and intramuscular difference in MT. When significant interactions were observed, rates of change in MT after RT were compared between regions using the one-way ANOVA with repeated measures and post hoc testing. **Results:** The two-way ANOVA showed that there was the main effect for time, but not for

the regions both in RF and VL. Significant interaction was shown only in VL. As for the rates of change in MT of VL, significantly greater rate was seen in the distal region than in the proximal region at 6 weeks, while there was no difference between regions at 4 and 8 weeks after RT. Discussion: Intramuscular difference in muscle hypertrophy after RT was observed only at 6 weeks in VL. This result suggests that the significant hypertrophy in the distal region may occur from 4 to 6 weeks, whereas the significant hypertrophy in the proximal region may occur from 6 to 8 weeks. That is, this result suggests that time course of change in MT after RT differs by region in VL. Previous study reported that oxygenation saturation after RT at the distal region of VL muscle was significantly greater than that at the middle region (Miyamoto et al., 2013). Our results which show that hypertrophy of distal region of VL occurred at early phase after RT may result from the difference in metabolic factor during RT between regions. Reference: Miyamoto N., Wakahara T., Ema R., Kawakami Y. (2013). *Clin Physiol Funct Imaging*, 33(6), pp463-469. Contact: E-mail: : araki.kouji@st.kyoto-u.ac.jp

### EFFECTS OF TENDINOUS TISSUE ON THE TORQUE-ANGLE RELATIONSHIP OF THE KNEE JOINT

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**Introduction** The joint torque generated by muscle contraction depends on the joint angle. Behavior of the tendinous tissues to which muscle fibers are attached is also likely to influence the torque-angle relationship. In general, the more the joint is passively extended, the greater the slack in tendinous tissues of extensor muscles. If the tendinous tissue does influence the torque-angle relationship, the discrepancy between length of muscle shortening and joint torque will increase as the joint is extended. This study was designed to clarify the relationship between joint torque and fascicle behavior in vivo and to examine the indirect contributions of tendinous tissues to joint torque. **Methods** Fifteen male subjects performed isometric knee extensions voluntarily (VOL) and electrically (ELE) at knee joint angles of 30°, 60° and 90° (0° = full extension). In the VOL condition, they increased knee joint torque (KJT) at the same rate every 3 s and let it reach the maximum in 27 s. The maximum torque was measured beforehand at 30° (59.7±21.1 Nm), 60° (121.4±34.2 Nm) and 90° (138.7±49.4 Nm), and divided into 9 intensity levels. In the ELE condition, electrical stimulation (ES) at 20 Hz was applied to the vastus lateralis muscle (VL) in the same way as VOL while the subjects were fully relaxed. The maximum ES was defined as the highest tolerable intensity (38.1±14.9 mA). VL activity was measured by electromyography (EMG) and movement by ultrasonography (USG). Changes in the point (P) where a fascicle arises from the deep aponeurosis and the pennation angle were calculated from USG. Results In VOL, strong positive relationships were observed between EMG and KJT at all knee joint angles. In ELE, KJT was almost constant at 30° regardless of ES intensity. As the knee joint angle became larger, positive relationships between ES intensity and KJT became gradually stronger. On the other hand, the smaller the knee joint angle, the larger P moved in the proximal direction, completely opposite to the result in VOL, where movement of P increased with knee joint angle. **Discussion** Maximum KJT evoked by ES (5.9±7.5 Nm) was much smaller than that exerted by voluntary contraction. An interaction between the small KJT and muscle slack may explain the relationships among KJT, ES intensity, and P movement in ELE. It is likely that tendinous tissue slack at more extended positions allowed for greater muscle length contraction but that the small force evoked by ES could not be transmitted to the joint. This is consistent with the increase in KJT with ES intensity at more flexed knee angles. In conclusion, joint torque was influenced not only by sarcomere length and moment arm but also by behavior of tendinous tissue. **References** Lieber RL, Boakes JL. (1988). *Am J Physiol*, 254, 759-768.

### INFLUENCE OF DIFFERENT GROUNDS DURING WALKING ON CORTICAL ACTIVITY

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**Introduction** Several studies on cortical brain activity substantiate a shift of electroencephalographic (EEG) activity during and after walking (e.g. Wagner et al., 2012). In the present study, we investigated the effects of walking on even and uneven grounds on EEG activity. We hypothesize an increase in beta activity due to walking on uneven ground as an indicator of maintaining a sensorimotor state under novel conditions of motion (see Engel & Fries, 2010). **Methods** 16 healthy subjects (22-29 years) performed a 20-minute walk at 0.8-0.9 m/s on two different grounds (even, uneven). Spontaneous resting EEG was recorded from 19 electrodes according to the international 10-20 system before, during, and after walking. Analysis of variance were performed for the data of power density for the theta (4.0-7.5 Hz), alpha (8.0-13.0 Hz), beta (13.0-30.0 Hz) and gamma (30.0-70.0 Hz) band. **Results** Results during eyes-open baseline show increased temporal ( $p < .05$ ), parietal ( $p < .01$ ) and occipital ( $p < .05$ ) alpha activity after walking on uneven ground compared to control condition. After walking on uneven ground, increased frontal ( $p < .05$ ), central ( $p < .01$ ), temporal ( $p < .05$ ) and parietal ( $p < .05$ ) theta activity as well as increased frontal ( $p < .05$ ), central ( $p < .05$ ) and temporal ( $p < .05$ ) alpha activity was measured at eyes-closed baseline. Increased central beta activity ( $p < .01$ ) occurs after walking on uneven ground during eyes-closed baseline. In comparison to control condition a higher temporal ( $p < .05$ ) and parietal ( $p < .05$ ) gamma activity was measured after walking on uneven ground in eyes-closed condition. **Discussion** Our results demonstrate that walking on uneven ground causes alterations of brain activity. While previous studies indicate decreased alpha and beta activity after walking on even ground (see Wagner et al., 2012), we found increased alpha and beta activity after walking on uneven ground. These findings indicate divergent cortical processing for walking on uneven ground. We assume that the alterations of brain activity result from higher affordances on somatosensory information processing for novel movements. Divergent activation patterns of theta activity may reflect increased attentional focusing during walking on uneven grounds. **References** Engel, A. K. & Fries, P. (2010). Beta-band oscillations- signalling the status quo? *Current Opinion in Neurobiology*, 20, 156-165. Wagner, J., Solis-Escalante, T., Grieshofer, P., Neuper, C., Müller-Putz, G. R. & Scherer, R. (2012). Level of participation in robotic-assisted treadmill walking modulates midline sensorimotor EEG rhythms in able-bodied subjects. *Neuroimage*, 63, 1203-1211. Contact johamaus@uni-mainz.de

### MONOSYNAPTIC REFLEX IN ATHLETES: COMPUTATIONAL MODELLING APPLIED TO ELECTROENCEPHALOGRAPHIC SIGNALS IN RANDOMIZED CONTROLLED TRIAL

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**Introduction** Monosynaptic reflex is triggered by a muscle stretch and consists into a rapid contraction of the muscle itself. The following study describes electro-cortical activity generated by a monosynaptic reflex on quadriceps femoris elicited by Babinski hammer jab; thus highlighting differences in the cortical activity between before and after stimulus and the changes due to a variation of the body position of the volunteer during the test. **Methods** Twenty healthy volunteers (10 females and 10 males, aged 24-28 years) were chosen from

athletes who practiced at least 6 hours of activity per week. Each volunteer, deprived of sight, received 20 stimulations of sub-patellar tendon, 10 in seated and 10 in supine decubitus position, performed with a Babinski hammer; the lengths of rest between stimuli were randomized (ranging from 5 to 10 s) to prevent that volunteers could expect the stimulus. To highlight the differences between the two times (pre and post stimulus) and the two positions (seated, decubitus) was used a 2-way ANOVA evaluating the contributions of each independent component (IC). After Kolmogorov-Smirnov test, clustering functions with K-means algorithm were used to assess the consistency of ICA decompositions across subjects and conditions. The level of significance was set at  $p < 0.05$  under False Discovery Rate. Results During pre-stimulus time were not statistically significant differences in electrocortical activity among the two positions; during post-stimulus time statistically significant differences among the two positions were found: seated position showed greater cortical activation than supine decubitus position at alpha, beta and gamma frequencies. Time-frequency analysis highlighted an activation (respect to the baseline) at about 160 ms after the stimulus at all frequencies; it's possible also to highlight a similar activation at about 250 ms after the stimulus at higher frequencies. Discussions Power spectrum analysis indicates differences due to a variation of the body position after monosynaptic reflex elicited, no one else studies investigated this topic. Time-frequency analysis indicates two periods when the electro-cortical field activity is significantly different respect to baseline; these results show the time for the transmission of informations in the spino-cortical (ascending) pathways, as shown by Spieser et al., in 2010. References Spieser L, Meziante H, Bonnard M (2010). Cortical mechanisms underlying stretch reflex adaptation to intention: A combined EEG-TMS study. *NeuroImage* 316-325. Contact [cugliarigiovanni@gmail.com]

## RELATIONSHIP BETWEEN INTRACORTICAL INHIBITION DURING PRESET AND PERFORMANCE DURING JUMP

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Introduction Drop jump (DJ) can be useful in improving the performance in many sports events. Previous studies reported that DJ performance is acted upon by variables such as pre-activation, stretch reflex and stiffness (Taube et al., 2012). Another study reported that short interval intracortical inhibition (SICI) before movement is supposed to play an important role in motor control (Reynolds & Ashby, 1999). Thus, we assumed that the preset state immediately prior to the jump off from drop heights also influences the DJ performance. The purpose of this study was to clarify the effect of SICI at preset state on DJ performance. Methods Male athletes participating in athletics were classified into two groups: jump athletes (jump group) and other athletes (other group). DJs were performed for three drop heights (30 cm, 45 cm and 60 cm). This DJ performance was evaluated by measuring the DJ-index (jump height/contact time) for each drop height. Motor evoked potentials were measured from the medial gastrocnemius muscle (MG) during preset in both groups (MG-SICI), and these potentials were measured from the tibialis anterior muscle (TA) only in the jump group (TA-SICI). SICI was evaluated using a paired-pulse transcranial magnetic stimulation (TMS) paradigm to the motor cortex. The measurements obtained from these muscles underwent different trials (MG-SICI and TA-SICI). The protocol was performed on the basis of two conditions: 1) DJs performed from each drop height with TMS during preset (pre30, pre45, pre60) and 2) TMS performed in the standing position (control). Results & Discussion DJ-index and jump height were significantly higher in the jump group as compared to the other group for all the drop heights. Contact time was significantly shorter in the jump group as compared to the other group for all the drop heights. MG-SICI was significantly decreased in the jump group as compared to the other group at pre60 in DJ trials. The jump group SICI was significantly decreased in pre60 trial as compared to the control trial and pre30. TA-SICI was only measured in the jump group and no differences were observed for any of the drop height. In the jump group we found that MG-SICI during preset decreased with an increased drop height. This was assumed to occur because the jump group regularly practiced movements that were similar to DJ that involved increased drop heights. Therefore, disinhibition of the agonist muscle during preset is thought to be important for DJ performance. References Taube W, Leukel C, Gollhofer A (2012). *Exercise and Sport Sciences Reviews*. 40 (2), 106-112. Reynolds C, Ashby P (1999). *Neurology*. 53, 730-735.

## Nutrition

### DIETARY NITRATE SUPPLEMENTATION: RELATIONSHIPS BETWEEN MUSCLE NITRATE CONCENTRATION, SUBMAXIMAL EXERCISE ECONOMY AND EXERCISE TOLERANCE

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Introduction It has consistently been reported that NO<sub>3</sub><sup>-</sup> supplementation significantly increases circulating plasma [NO<sub>3</sub><sup>-</sup>] and [NO<sub>2</sub><sup>-</sup>]. However, it is currently unknown whether dietary NO<sub>3</sub><sup>-</sup> supplementation can increase [NO<sub>3</sub><sup>-</sup>] within skeletal muscle tissue, and whether this is important in eliciting the physiological and performance effects previously reported. Therefore the aim of this study was to assess the relationship between skeletal muscle [NO<sub>3</sub><sup>-</sup>], pulmonary VO<sub>2</sub> responses and exercise tolerance to constant-work-rate exercise following NO<sub>3</sub><sup>-</sup> supplementation. These data may enable better understanding of the mechanisms by which dietary NO<sub>3</sub><sup>-</sup> supplementation can affect exercise economy and exercise tolerance. Methods Following ethical approval, eight healthy males supplemented their diet with 140 ml-d<sup>-1</sup> of NO<sub>3</sub><sup>-</sup>-rich beetroot juice (8.4 mmol NO<sub>3</sub><sup>-</sup>; BR) and 140 ml-d<sup>-1</sup> of nitrate-depleted beetroot juice (PL) for 3-days prior to moderate and severe-intensity cycle exercise trials in a double-blind, randomised, crossover design. Plasma [NO<sub>2</sub><sup>-</sup>], [NO<sub>3</sub><sup>-</sup>] and pulmonary VO<sub>2</sub> was measured at rest and during exercise, and muscle [NO<sub>3</sub><sup>-</sup>] was determined from muscle biopsies before and immediately after the exercise bouts. Results Overall muscle [NO<sub>3</sub><sup>-</sup>] was 72% higher following BR compared to PL (BR: 27.8 ± 11.7 vs. PL: 16.2 ± 8.9 nmol/mg DW,  $P < 0.05$ ). Plasma [NO<sub>2</sub><sup>-</sup>] (BR: 493 ± 287 nM, vs. PL: 43 ± 34 nM,  $P < 0.05$ ) and [NO<sub>3</sub><sup>-</sup>] (BR: 238 ± 79 vs. PL: 11 ± 4 μM,  $P < 0.05$ ) were higher following BR compared to PL. The change in muscle [NO<sub>3</sub><sup>-</sup>] following BR compared to PL was positively correlated with the change in severe-intensity exercise tolerance ( $r = 0.67$ ;  $P < 0.05$ ). The change in steady-state VO<sub>2</sub> during moderate-intensity exercise following BR compared to PL was negatively correlated with the change in severe-intensity exercise tolerance ( $r = -0.66$ ;  $P < 0.05$ ). Conclusion Short-term dietary supplementation with BR increases muscle [NO<sub>3</sub><sup>-</sup>] as well as plasma [NO<sub>2</sub><sup>-</sup>] and [NO<sub>3</sub><sup>-</sup>]. Relationships between muscle [NO<sub>3</sub><sup>-</sup>], steady-state VO<sub>2</sub> and severe-intensity exercise tolerance suggest that improved skeletal muscle efficiency consequent to greater NO bioavailability (as inferred from greater muscle [NO<sub>3</sub><sup>-</sup>]) following BR may promote improved exercise performance. Additional work is required to clarify the inter-relationships between skeletal muscle NO bioavailability (and its malleability via dietary supplementation), metabolic and mechanical efficiency, and fatigue resistance and performance. Contact J.A.Kelly@exeter.ac.uk

## NO EFFECT OF ORAL TYROSINE ADMINISTRATION ON MOOD AND MOTIVATION OR HEART RATE VARIABILITY DURING ENDURANCE PERFORMANCE IN THE HEAT.

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**Introduction** Acute oral administration of the catecholamine precursor tyrosine has been associated with increased exercise tolerance in the heat, perhaps due to maintenance of central and/or peripheral catecholamine function. Therefore, we examined whether acute tyrosine administration affects subjective mood and motivation and heart rate variability during prolonged exercise performance in the heat. **Methods** Seven male, endurance cyclists (median age 20 (range, 26) years, median stature 1.83 (0.13) m, mean body mass 77.9 ( $\pm$  11.7, SD) kg, peak oxygen uptake 4.6 ( $\pm$  0.6) l $\cdot$ min<sup>-1</sup>), unacclimated to exercise in the heat, performed two trials separated by 7 d. Subjects drank 500 ml of sugar-free flavoured tap water containing 150 mg $\cdot$ kg body mass<sup>-1</sup> tyrosine (TYR) or an isocaloric quantity of hydrolysed whey powder (PLA), in a randomised, double-blind fashion. After an hour they performed 60 min of constant-load exercise at 57 ( $\pm$  4) % peak oxygen uptake followed by a simulated cycling time trial lasting approximately 35 min. Mood and motivation were assessed using validated questionnaires (UWIST mood checklist and Dundee Stress State Questionnaire, respectively), at pre-exercise before drinks administration and after 53 min of constant-load exercise. Heart rate variability during the time trial was assessed using a Polar heart rate monitor continuously logging the oscillatory interval between heart beats and analysed in the time and frequency domains using automated analysis software (Kubios HRV version 2.0). Results Mood questionnaire subscale scores ( $P > 0.05$ ) and success ( $P = 0.499$ ), intrinsic ( $P = 0.718$ ) and overall motivation ( $P = 0.986$ ) were similar between trials. Tense arousal increased from pre-exercise in both trials ( $P = 0.172$ ). Mean heart rate variability during 20 min of the time trial (last common time-point at which all subjects were still exercising,  $P = 0.444$ ) and during consecutive 5 min periods did not differ between trials ( $P = 0.447$ ). Standard deviation of all normal to normal heart beats declined after 5 min of time trial ( $P = 0.018$ ) to a similar extent in both trials ( $P > 0.05$ ). Square root of the mean squared differences of adjacent normal to normal intervals did not differ between trials ( $P > 0.05$ ). Low frequency ( $P = 0.655$ ), high frequency ( $P = 0.499$ ) and low frequency: high frequency ( $P = 0.546$ ) power spectra, total power ( $P = 0.587$ ) over 20 min of the time trial, and consecutive 5 min periods ( $P > 0.05$ ) were similar between trials. **Discussion** Acute administration of a catecholamine precursor, in a dose previously reported to increase exercise capacity in the heat, did not influence subjective mood and motivation nor heart rate variability in hyperthermic participants. Contact llf07@aber.ac.uk

## NUTRITIONAL PRACTICES IN TRAINED CYCLISTS PRIOR TO AND DURING AN ULTRA-ENDURANCE CYCLOSPOITIVE

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**Introduction** Cyclosporitive events often take riders > 5 hours to complete. These events therefore require considerable training and appropriate nutritional strategies prior to and during the event if optimal performance is to be achieved. Recently, the recommendations for carbohydrate (CHO) ingestion during exercise bouts > 4 hours have been increased to 90 g/hr, but little is known about the habitual ingestion strategies of these athletes in preparation for and during cyclosporitive events. The aim of the study was to determine the caloric intake of trained cyclists prior to and during an ultra-endurance cycling event. **Methods** Eight trained male cyclists (age 40.3 $\pm$ 6.6 yr, weight, 79.6 $\pm$ 7.2 kg) completed a 241 km undulating route with 3225 m of vertical ascent at a mean ambient temperature of 17.5 (range 12.2 – 22.2) C. During the event, food stations at 103, and 196 km provided participants with opportunities to ingest additional food and fluid. Records of ingestion during each section of the event and at each station. Prior to the event participants also completed a 3-day diet diary. Dietary analysis was used to calculate total caloric intake and rate of CHO ingestion during the event. Perceptions of fullness, thirst, muscle aches and effort were also measured prior to the start, at each station and at the end of the event. One sample t-tests were used to compare CHO ingestion rates to recommended amounts and repeated measures ANOVA was employed to determine changes in perceptual responses during the event. Results Mean caloric content of the pre-event diets for the 3-days was 3032.6  $\pm$  537.4 kcal with 3907.0  $\pm$  910.9 kcal ingested on the day prior to the event. Participants achieved just 5.8 g/kg CHO, which is significantly lower than the recommended intake (mean diff = 4.2 g/kg,  $t = 8.47$ ,  $p < 0.001$ , ES = 0.95). The pre-event meals contained 638.1  $\pm$  222.9 kcal and during the event riders consumed 2356.7  $\pm$  654.0 kcal. Rates of CHO ingestion during the event of 40.9  $\pm$  12.2 g/hr were significantly lower than recommended (mean diff = 49.1 g/hr,  $t = 11.36$ ,  $p < 0.001$ , ES = 0.97). Stomach fullness was unchanged ( $f = 2.08$ ,  $p = 0.133$ , ES = 0.23), but thirst ( $f = 14.71$ ,  $p < 0.001$ , ES = 0.68), muscle aches ( $f = 50.54$ ,  $p < 0.001$ , ES = 0.88), and effort ( $f = 67.10$ ,  $p < 0.001$ , ES = 0.91) increased significantly during the course of the event. **Conclusion** The cyclists ingested insufficient CHO in the days leading up to and during the ultra-endurance event. This prevented them from achieving an optimal nutritional strategy, with likely negative performance implications. Contact Andy.Sparks@edgehill.ac.uk

## SODIUM CITRATE SUPPLEMENTATION ENHANCES TENNIS SKILL PERFORMANCE

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**Introduction** The primary aim of this study was to investigate the effect of sodium citrate (SC) supplementation on skilled tennis performance. **Methods** Ten Brazilian nationally ranked young male tennis players (age: 17.0  $\pm$  1.2 years; height: 176.7  $\pm$  5.2cm; weight: 68.4  $\pm$  7.9kg; body fat: 11.7  $\pm$  1.4%) participated in this crossover, placebo-controlled, double-blind study. The experimental study design comprised three days: day-1 was used as a familiarization session for selected tests (the skill tennis performance test [STPT] and the repeated-sprint ability shuttle test [RSA]), day-2 (3 days after day-1) and day-3 (10 days after day-2) were experimental testing sessions. Upon arrival (baseline-BL) in the experimental sessions, a baseline (BL) blood sample was collected for metabolic analysis of metabolic parameters (i.e. base excess-BE, pH, bicarbonate-HCO<sub>3</sub>, and blood lactate-[La]). Following blood collection subjects ingested either SC (0.5g.kg-1BW in capsules of 500mg) or a placebo (PLA-NaCl 0.1g.kg-1BW + Pounder 0.4g.kg-1BW in capsules of 500mg). Two hours later, a pre-match blood sample was collected then STPT and RSA tests were performed followed by a 1-hour simulated match. Immediately following the simulated match, a post-match blood sample was collected, and STPT, and RSA tests were again administered. Finally, 30-minutes later subjects recorded a session-RPE and completed a gastrointestinal (GI) questionnaire. Results There was no difference ( $p > 0.05$ ) between conditions for metabolic parameters at BL. A significant increase in all metabolic parameters (BE, pH, HCO<sub>3</sub>, [La];  $p < 0.05$ ) was detected from BL to pre-match and was sustained at post-match in SC. Additionally, each metabolic parameter was greater (BE, pH, HCO<sub>3</sub>, [La];  $p < 0.05$ ) in SC trial compared to PLA trial at pre- and post-match time points. A greater shot consistency ( $p < 0.05$ ) at post-match in the STPT was observed in SC compared to PLA. Furthermore, a greater amount of games won was noticed in the SC condi-

tion (vs. PLA;  $p < 0.05$ ) during the simulated match. There was no difference ( $p > 0.05$ ) between conditions for RSA performance or session-RPE score. Importantly, no subjects reported any severe GI distress symptoms during either condition. Discussion CS supplementation significantly increased all metabolic parameters (i.e. BE, pH, HCO<sub>3</sub>, [La]) and enhanced skilled tennis performance (i.e. percent shot consistency and games won during simulated match play) compared to a PLA condition. Moreover, no players reported any significant GI discomfort following SC supplementation. Therefore, from a practical perspective, it appears that SC supplementation can be safely and effectively utilized in tennis players to enhance specific skill performance. email: caroline.capitani@fca.unicamp.br

### **EFFECT OF NITRATE-RICH BEVERAGES ON AVERAGE POWER, PEAK POWER, HR, AND RPE IN MODERATELY ACTIVE YOUNG ADULTS**

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**INTRODUCTION** Known to athletes as an ergogenic aid, nitric oxide enhances blood flow. In a systematic review, Hoon, et.al. (2013) suggests that increased dietary nitrate can increase athletes' endurance during exercise and lower rate of perceived exertion (RPE). Whole beetroot and beetroot juice have frequently been tested in athletes; however, nitrate-rich spinach and non-trained athletes have not been thoroughly tested. The aim of this research was to evaluate effects of nitrate-rich beverages on anaerobic power, endurance, heart rate (HR) and RPE in moderately active male and females. **METHODS** Within a randomized cross-over design, participants were placed into three groups with groups receiving a different beverage over three test weeks. After initial analysis, participants were classified as a trained athlete or recreational athlete for secondary analysis. Before each trial, participants consumed a control beverage or 1500 mg of nitrate from nitrate-rich beverages (freshly prepared spinach or commercially prepared Biotta beetroot juice) in a random order. For testing, participants were fitted with a Polar heartrate monitor and tested on a Monark 884 E Sprint bike using a 7 sec Wingate protocol. SPSS and Vassarstats were used for descriptive statistics and repeated measures ANOVA. **RESULTS** Participants (n=17, 11 male, 6 female) consisted of healthy college students of ages  $22.7 \pm .9$  years, mass of  $80.6 \pm 4.0$  kg, and stature of  $176.2 \pm 1.7$  cm. Endurance was defined as number of stages completed during a Wingate trial. Average stages (M $\pm$ SD) completed after consumption of control ( $24 \pm 5$ ), spinach ( $28 \pm 7$ ), and beetroot ( $24 \pm 5$ ) beverages were not significantly different ( $p \leq 0.05$ ). No significant differences were found in average or peak power, RPE and HR. However, secondary analysis of a subset of trained athletes (n=9) tended to show a greater variation in endurance (control:  $31 \pm 9$ , spinach:  $41 \pm 2$ , and beet root juice ( $35 \pm 9$ ) and RPE (control:  $17 \pm 1$ , spinach:  $16 \pm 1$ , beet root:  $15 \pm 1$ ). Although not significantly different, a larger sample size of trained athletes may have supported differences in effects associated with the nitrate-rich beverages. **DISCUSSION** Past research primarily focused on well-trained athletes (Cermak et al., 2012). In the current study, trained athletes tended to have a greater willingness to push through physical discomfort than recreationally active participants during the Wingate test. Data tended to show differences of nitrate-rich beverages on trained participants, supporting future research focused on athletes and different tests for endurance. **REFERENCES** Hoon, M., Johnson, N. Chapman, P., Burke, L. (2013). In. *J Sport Nutr & Exercise Metabolism*, 23, 522-532. Cermak, N., Gibala, J., van Loon, L. (2012). In. *J Sport Nutr & Exercise Metabolism*, 22, 64-71.

### **PLASMA CREATINE KINETICS AFTER INGESTION OF NOVEL MICROENCAPSULATION DELIVERY FOR CREATINE MONOHYDRATE WITH ENHANCED STABILITY IN AQUEOUS SOLUTIONS**

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**Introduction** Creatine supplementation is a well-established ergogenic aid for enhancing sport and exercise performance. While creatine represents one of the largest sports supplement markets, the degradation of creatine to creatinine presents a major concern for the sports supplement industry, since this is a clear indication of creatine instability, and therefore reduces the effectiveness of oral supplementation when delivered in ready-to-drink format (Jager et al., 2011). Microencapsulation is an emerging technology capable of enhancing stability and bioavailability of bioactives in aqueous solutions. The aim of the present study was to investigate the plasma kinetics of creatine after ingestion of creatine monohydrate delivered using a novel microencapsulation method (Anabio Technologies). **Methods** In a double blind design, physically-active male participants were randomly assigned to ingest a 70 mL shot either containing 3 g of microencapsulated creatine monohydrate (CM) (n=5), or a placebo (PLA) (n=5) containing 3 g of maltodextrin. Plasma creatine concentrations were assessed at baseline before ingestion and every 30 min for 3 h after ingestion. **Results** Plasma creatine concentrations were unchanged in the PLA group, and averaged  $\sim 45 \mu\text{M}$ . In the CM group, plasma creatine concentration peaked after 30 min at  $101.6 \pm 14.9 \mu\text{M}$  ( $p < 0.05$ ), representing a 2.3-fold increase over resting concentrations. Thereafter, plasma creatine concentration gradually declined downwards towards baseline levels, but remained significantly elevated ( $\sim 50\%$  above baseline levels) at 3 h after ingestion. **Discussion** These results confirm that microencapsulated creatine monohydrate is stabilized and remains bioavailable when delivered in an aqueous solution, suggesting potential use of microencapsulation for ready-to-drink formulations for creatine supplementation. Future work will focus on the ability of a supplementation protocol with this delivery method to increase muscle creatine concentrations and enhance exercise performance. **Reference** Jager R, Purpura M, Shao A, Inoue T, Kreider RB (2011) Analysis of the efficacy, safety and regulatory status of novel forms of creatine. *Amino Acids* 40, 1369-1383.

### **EFFECT OF A MEDITERRANEAN DIET ON INFLAMMATORY AND CARTILAGE DEGRADATION MARKERS IN OSTEOARTHRITIS**

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**Introduction** Osteoarthritis (OA) is a group of chronic, painful, disabling conditions. Traditionally thought of as a disease of degradation only, inflammation is now also recognised in OA. Whilst current management strategies include exercise, weight loss and pharmacological therapies, there is evidence to suggest that particular food sources consistent with a Mediterranean type diet (e.g. rich in omega-3 fatty acids) may slow the pathogenesis of degenerative joint diseases and moderate inflammation. The aim of the present study was to assess whether following a Mediterranean type diet would moderate selected biomarkers of relevance to OA. **Methods** Following full institutional ethical approval, 61 participants with OA were randomly allocated to an experimental (DIET) or control (CON) group (54 completed: DIET = 29, CON = 25). Participants completed a 7d food frequency questionnaire (FFQ) pre-intervention and at months 2 and 4 (post-intervention). Venous blood samples were taken pre- and post-intervention to obtain serum for analysis of serum cartilage oligomeric matrix protein (COMP) (a marker of cartilage degradation) and other inflammatory and/or OA-related biomarkers (including a



panel of pro- and anti-inflammatory cytokines, in addition to MCP-1 and MMP-9). The CON group were asked to maintain their usual activity and dietary practices, whereas the DIET group were asked to follow dietary guidelines consistent with a Mediterranean type diet. Compliance was assessed by the 2 and 4 month FFQs. Results and Discussion Adherence to the guidelines increased in the DIET group (group  $\times$  time interaction  $P = 0.047$ ): no change in CON group ( $P = 0.493$ ), significant improvement in DIET group ( $P = 0.046$ ). Furthermore, 23 out of 29 participants improved compliance from low ( $< 65\%$ ) to high ( $> 65\%$ ) in DIET compared to 4 of 25 in CON (Chi square test  $P < 0.001$ ). There were no differences between groups in the response of any biomarker, except the pro-inflammatory cytokine IL-1 $\alpha$  (interaction  $P = 0.019$ ), which decreased pre-to post-intervention in the DIET group ( $0.43 \pm 0.38$  to  $0.23 \pm 0.29$  pg/ml,  $P = 0.01$ ) compared to no change in CON ( $0.21 \pm 0.21$  to  $0.23 \pm 0.22$  pg/ml), although interpretation of this is complicated by the pre-intervention difference between groups. A similar, albeit non-significant (interaction  $P = 0.057$ ) pattern was evident for COMP (DIET  $13.1 \pm 4.7$  to  $12.1 \pm 4.5$  U/L; CON  $10.9 \pm 2.4$  to  $11.0 \pm 2.2$  U/L, noting that  $\leq 12$  U/L is considered 'normal'). The dietary intervention had little impact on the biomarkers investigated. However, the DIET group did lose  $\sim 1.6$  kg ( $-2.1\%$ ) body mass. Changes in body mass have been demonstrated to benefit OA, therefore future studies should examine longer periods and include exercise interventions that may cause greater weight loss.

### PROBIOTICS SUPPLEMENTATION IMPROVE MOOD STATE AFTER MARATHON

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Introduction Supplementation of microorganisms and their effects on the central nervous system (CNS) are matters of recent interests of researchers. Some studies suggest that the microbiome created by probiotics can modify brain functions and they are utmost importance for normal CNS health. A two-way communication system between gastro-intestinal system and CNS could be mediate by the effects of probiotics supplementation on mood state before and after a marathon race. The purpose of this study was to determine whether probiotic supplementation alters mood status before and after a marathon – race 42,195 km. Methods Twelve marathoners aged 30-45 years were supplemented with probiotics or placebo in capsules 2,0g, one capsule per day for 30 consecutive days of Lactobacillus Acidophilus, Lactobacillus Casei, Lactobacillus Lactis, Bifidobacterium Lactis and Bifidobacterium Bifidum 109 UFC or cornstarch as placebo. After this month all individuals underwent a marathon, implying that they realized that distance in shortest time possible. The volunteers were randomly separated, five in the placebo group (PCG) and seven in the probiotics group (PBG). Before and after the race, the volunteers answered the Brunel Mood Scale questionnaire (Terry et al., 2003) to measure mood profile. The protocol was approved by Unifesp Ethics Committed (#691.519). Results Tension was significantly lower in probiotic's group (PCG  $1.40 \pm 0.34$ ; PBG  $0.57 \pm 0.38$   $p < 0.05$ ); Stamina was significantly higher on probiotic's group (PCG  $6.00 \pm 3.60$ ; PBG  $13.71 \pm 2.75$ ,  $p < 0.05$ ). Depression, Anger, Fatigue there was no significant differences and Mental Confusion was significantly higher in both groups compared pre and post-race (PCB Pre  $0.80 \pm 3.10$ , Post  $5.83 \pm 3.56$ ) and (PBG Pre  $1.14 \pm 1.01$ , Post  $5.28 \pm 1.22$ )  $p < 0.05$ . The data were described as mean  $\pm$  standard deviation. Comparison between the pre and post condition was assessed using repeated measures ANOVA and significance  $p < 0.05$ . Discussion Probiotic supplementation was able to modulate mood, decreasing significantly tension and increasing significantly the stamina, but it was not sufficient to recovery mental confusion after marathon suggesting strong influence of microbiome on the CNS as describe by Tillisch K, 2014. References Terry, P.C.; Lane, A.M.; Fogarty, G.J. Construct Validity Of The Poms-A For Use With Adults. Psychology Of Sports And Exercise. United Kingdom, V.4, N.2, P.125-139, Abr. 2003. Tillisch K, 2014 He Effects Of Gut Microbiota On Cns Function In Humans. Gut Microbes May-Jun;5(3):404-10. Doi: 10.4161/Gmic.29232. Contact edgar\_tds@hotmail.com

### CAN RESISTANCE TRAINING AND SUPPLEMENTATION WITH LEUCINE ATTENUATE THE LOSS OF STRENGTH IN DIABETIC RATS?

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INTRODUCTION Diabetes is associated with important health complications, including a decline in muscular strength, which may impair functional capacity and quality of life of diabetics. Resistance training is described as having a role in enhancement of strength and supplementation with leucine may potentialize these effects. Hence, the aim of this study was to determine the effects of resistance training and supplementation with leucine on gain of strength in diabetic rats. METHODS Three groups were analyzed in this study: healthy but sedentary (to compare the level of strength between this group and diabetics with interventions), diabetic submitted to resistance training and supplemented with leucine (DTL) or non-essential amino acids (DTA, control of leucine). 5-day old male Wistar rats were inoculated with streptozotocin (120 mg/kg in 10 mmol/L of sodium citrate buffer, pH 4.5; diabetics) or sodium citrate buffer (healthy). After 21 days-old, diabetic rats were fed with isonitrogenous diet containing 5% leucine or 5% non-essential amino acids, and submitted to resistance training, consisted of 4-9 climbs in ladder. The rats were adapted during 1 week (4th week), and trained once every 3 days for 8 weeks with progressive loads. On the first day of 5th and 12th week of the experiment, maximum repetition tests were performed. Results were obtained based on the ratio between maximum weight lifted in one repetition and total body weight of rats. Differences between the groups were determined by one-way ANOVA followed by Tukey's post-hoc test. The significance level adopted was  $p = 0.05$ . RESULTS On the first test (before resistance training), healthy rats expressed more pronounced strength than DTA group (19%;  $p < 0.05$ ). However, on the second test (after 8 weeks of resistance training), strength was improved in DTL and DTA groups compared to healthy group (56% and 55% respectively;  $p < 0.001$ ). CONCLUSION Despite the fact that diabetes induces a markedly loss of strength, the results showed that strength was higher in trained diabetic rats than in healthy but sedentary rats, suggesting that resistance training was capable to attenuate the decline in muscular strength. The results also showed similar values to both diabetic groups, suggesting that both leucine and non-essential amino acids, in this concentration, promoted similar effects on muscular strength. Supported by FAPESP and CNPq (Brazil) CONTACT tirapegu@usp.br

### IS A HIGH CARBOHYDRATE INTAKE SUSTAINABLE DURING ULTRA-ENDURANCE RUNNING EVENTS?

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Introduction The International Olympic Committee advises athletes to consume up to 90 g carbohydrate (CHO) per hour during ultra-endurance events by using products providing multiple transportable CHOs (IOC, 2011). Whilst high intakes ( $> 60$  g/h) have been reported in cycling events (Havemann & Goedecke, 2008), intakes in running events tend to be lower. The purpose of this study was to observe the dietary intakes of mountain marathoners who had been given CHO intake guidelines, to identify source of CHO ingested, associations

with performance, and possible barriers to meeting recommendations. Methods Sixteen male participants [mean age: 42 (SD: 15) y, body mass index: 24.0 (SD: 2.5) kg/m<sup>2</sup>] entered in the Longmynd Hike [50 mile mountain race] received written guidelines for CHO intake. Participants completed a weighed food inventory of all items consumed during the race. Data are expressed as means (SD), statistical significance  $p < 0.05$ . Qualitative data regarding adherence to the recommendations was collected via a post-race questionnaire. Results Hourly CHO consumption was lower than recommended [36 (13) g/h, range: 16-57 g/h], yet positively correlated with performance ( $r = 0.622$ ,  $p = 0.017$ ). Percentage of energy and CHO from sports products also showed strong correlation with performance ( $r = 0.556$ ,  $p = 0.039$ ;  $r = 0.650$ ,  $p = 0.012$ , respectively). Seventy-five percent of participants used sport supplements, yet they accounted for only 24% of total CHO intake. Comparison of nutrient intakes from competitors using sports products [energy: 11.9 (2.8) kJ/kg/h, CHO: 41 (9) g/h, 71 (10) % energy, fat: 22 (8) % energy, protein: 7 (2) % energy,  $n = 12$ ] versus those not [energy: 7.3 (0.9) kJ/kg/h, CHO: 19 (3) g/h, 53 (5) % energy, fat: 39 (4) % energy, protein: 8 (0.9) % energy,  $n = 4$ ], showed a more favourable nutrient profile for the former. The most common barrier to consuming higher intakes of CHO was that the quantity of food was too great. Discussion It has been proposed that sub-optimal intakes of CHO in such events may be due to the practical difficulties of ingesting foods whilst running (Kimber et al., 2002). However, the relatively high proportion of energy derived from fat and protein in this sample, coupled with the qualitative data, suggest it may also be due to over-consumption of whole foods. Athletes may be choosing a selection of whole sources in order to avoid sensory-specific satiety that might occur with high-CHO sports products. More research and guidance is needed to help athletes sustain higher CHO intakes over longer races, whilst limiting overall food intake and possible flavour fatigue. References Havemann L & Goedecke JH (2008). *Int J Sport Nutr Exe*, 18: 551-566. IOC (2011). *J Sports Sci*, 29: S3-S4. Kimber NE, Ross JJ, Mason SL et al. (2002). *Int J Sport Nutr Exe*, 12: 47-62.

## INTEREST OF CREATINE SUPPLEMENTATION IN SOCCER

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Introduction Studies have consistently indicated that creatine supplementation increases muscle creatine and phosphocreatine concentrations by approximately 15 to 40%, enhances anaerobic exercise capacity, and increases training volume leading to greater gains in strength and power (Cooper et al., 2012). Soccer can be described as an intermittent prolonged-duration high-intensity exercise. In terms of physiology, phosphocreatine and muscular glycogen are the two primary energy sources used by soccer players (Bangsbo et al., 2006). Therefore, this article aimed to summarize the current state of understanding on creatine supplementation for soccer players. Methods Searches were performed using PubMed and SPORTDiscus. Key terms used were ("creatine" OR "creatine supplementation") AND ("soccer" OR "football"). In order to meet the inclusion criteria, an article had to involve soccer players and investigate the potential ergogenic effect of creatine supplementation on soccer-specific skills and performance. Eight articles in total were retrieved from the computerized searches (Claudino et al., 2014; Williams et al., 2014; Mohebbi et al., 2012; Manchado et al., 2008; Ostojic, 2004; Cox et al., 2002; Larson-Meyer et al., 2000; Mujika et al., 2000). Results Creatine supplementation can have positive effects on dribble, sprint and vertical jump performances in soccer players. This supplementation may also enhance soccer players' muscle strength and adaptation to a high-intensity training regimen. In addition, creatine may be able to enhance muscle glycogen storage, reduce oxidative stress, and improve muscular repair and hypertrophy. It may have a protective effect against proteolysis during the first weeks of pre-season training and/or after intensive practices preceded by a long rest period. Creatine supplementation does not seem to affect aerobic performance. Discussion Soccer players could take creatine during pre-season training (3 to 5 g/day) in order to help them endure a high-intensity training regimen and/or enhance their muscular strength and adaptation. The same dosage might also be sufficient and beneficial during the season in case of fatigue, in order to sustain adequate levels of creatine, phosphocreatine and glycogen in the muscles, or to also give a physical (and mental) boost before games and extenuating practices. Further research is needed regarding the aerobic part of soccer. References Bangsbo, J., Mohr, M., & Krstrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *Journal of sports sciences*, 24(07), 665-674. Cooper, R., Naclerio, F., Allgrove, J., & Jimenez, A. (2012). Creatine supplementation with specific view to exercise/sports performance: an update. *Journal of the International Society of Sports Nutrition*, 9(1):33, 1-11. Contact Kevin.miny@ulg.ac.be

## THE EFFECTS OF CAFFEINE INGESTION TIMING ON ACUTE TESTOSTERONE AND CORTISOL RESPONSES TO RESISTANCE EXERCISE

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Caffeine ingestion has been shown to affect hormonal responses to resistance exercise. However, few studies examined effects of caffeine ingestion timing on acute responses of anabolic and catabolic hormones to a single bout of resistance exercise. PURPOSE: The purpose of this study was to examine the effects of different caffeine ingestion timing on acute hormonal responses to a single bout of resistance exercise (RE). METHODS: Twelve university male students (age, 21.4±1.9 yr; mass, 70.1±4.8 kg) who regularly performed RE participate in this study. All subjects performed 1RM test, then assigned to four treatments: caffeine ingestion 60 min prior to RE (PRE60, 6 mg/kg), caffeine ingestion prior to RE immediately (PRE-EXE, 6 mg/kg), caffeine ingestion during RE (EXE, 6 mg/kg) and control (CON) in counter balance order and within subject crossover design. All subjects ingested caffeine according to each treatment, then, the subjects performed RE (two exercises, 5 sets of 10 repetitions at 75% of 1RM). Blood samples were collected prior to caffeine ingestion (baseline, BL) and 0, 15, 30 min post to RE (P0, P15, P30) for analysis of testosterone, cortisol, insulin, blood lactic acid, glucose and free fatty acid. Each experiment separated by 7 days. In this study, statistical analysis of a two-way analysis of variance (treatment by time) with repeated measures was applied. Statistical significance set at  $\alpha = 0.05$ . RESULTS: After ingesting caffeine, the concentration of free fatty acid (P0) in PRE60 was significantly higher than CON (0.57±0.09 vs. 0.41±0.10 mmol/L) ( $p < 0.05$ ). The responses of testosterone (P0, P15, P30) (PRE60: 676.75±145.82, 643.38±149.25 and 575.50±192.44; PRE-EXE: 654.25±121.23, 619.50±121.63 and 571.25±123.97 vs. CON: 584.75±136.19, 531.25 ±146.57 and 496.38±137.42 ng/dl,  $p < 0.05$ ) and cortisol (P0, P15, P30) (PRE60: 23.31±3.00, 22.02±2.16 and 20.13±2.78; PRE-EXE: 22.29±2.84, 21.86±2.23 and 20.3±4.40 vs. CON: 18.40±2.30, 17.92 ±2.41 and 16.21±2.10 µg/dl,  $p < 0.05$ ) were significantly higher than CON in PRE60 and PRE-EXE. However, no significant difference was seen in resting and after RE concentrations between treatments for insulin ( $p > 0.05$ ). CONCLUSION: The results of this study indicated that caffeine ingestion prior to RE (PRE60 and PRE-EXE) will significantly affect the acute hormonal responses. However, caffeine ingestion during RE might not significantly change acute responses of anabolic and catabolic hormones.

### **PASSIVE SMOKING REDUCES AND VITAMIN C INCREASES EXERCISE-INDUCED OXIDATIVE STRESS: DOES THIS MAKE PASSIVE SMOKING AN ANTI-OXIDANT AND VITAMIN C A PRO-OXIDANT STIMULUS?**

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**INTRODUCTION** The current interpretative framework states that, for a certain experimental treatment (usually a chemical substance) to be classified as 'anti-oxidant', it must possess the property of reducing (or even nullifying) exercise-induced oxidative stress. The aim of the study was to compare in the same experimental setup, redox biomarker responses to an identical acute eccentric exercise session, before and after chronic passive smoking (considered a pro-oxidant stimulus) or vitamin C supplementation (considered an anti-oxidant stimulus). **METHODS** Twenty men were randomly assigned into either passive smoking or vitamin C group. All participants performed two acute eccentric exercise sessions, one before and one after either exposure to passive smoking or vitamin C supplementation for 12 days. Vitamin C, oxidant biomarkers (F2-isoprostanes and protein carbonyls) and the non-enzymatic antioxidant (glutathione) were measured, before and after passive smoking, vitamin C supplementation or exercise. **RESULTS** It was found that chronic exposure to passive smoking increased the level of F2-isoprostanes and decreased the level of glutathione at rest, resulting in minimal increase or absence of oxidative stress after exercise, contrary to the current scientific consensus. Conversely, chronic supplementation with vitamin C decreased the level of F2-isoprostanes and increased the level of glutathione at rest, resulting in marked exercise-induced oxidative stress. If these findings are explained within the current framework, a rather confusing conclusion is reached that passive smoking acted as an anti-oxidant stimulus and vitamin C as a pro-oxidant stimulus. **DISCUSSION** Although it is straightforward to define oxidants and reductants chemically, characterising the effects of an "oxidant" or an "anti-oxidant" in a biological environment has proven to be a very difficult task. We provide for the first time empirical evidence that the current interpretative framework of exercise-induced oxidative stress can be misleading and we propose a novel one. Contrary to the current scientific consensus, our results show that, when a pro-oxidant stimulus is chronically delivered, it is more likely that oxidative stress induced by subsequent exercise is decreased and not increased. Reversely, it is more likely to find greater exercise-induced oxidative stress after previous exposure to an anti-oxidant stimulus. We believe that the proposed framework will be a useful tool to reach more pragmatic explanations of redox biology phenomena. **CONTACT** nikolaidis@auth.gr

### **CARBOHYDRATE SUPPLEMENTATION INCREASES HSP-70 CONCENTRATION AFTER STRENUOUS EXERCISE IN HYPOXIA**

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**CARBOHYDRATE SUPPLEMENTATION INCREASES HSP-70 CONCENTRATION AFTER STRENUOUS EXERCISE IN HYPOXIA** **Introduction** There is controversy regarding the effect of exercise on HSP-70 concentration at sea level. On the other hand, exercise in hypoxic conditions represents an additional stress to the organism compared with exercise in normoxia (Mazzeo, 2008). In extreme environmental conditions, especially in hypoxia, the organism suffers several changes including a physiological and biochemistry changes. The aim of this study was to evaluate the effects of carbohydrate supplementation on the serum concentration of HSP-70 after strenuous exercise in hypoxic conditions simulating altitude at 4,500 m. **Methods** Nine healthy and physically active men were submitted to two sessions of exercise at an intensity of 70% VO<sub>2</sub>peak until exhaustion in a normobaric chamber (Colorado Altitude Training\_ (CAT)/CAT-12 Air Unit) simulating altitudes of up to 4500 m. These sessions were as follows: 1) hypoxia with placebo (Crystal Light® - Kraft Foods, Inc. strawberry), 2) hypoxia with supplemented 8% maltodextrin (200 mL/20 min, during and 2 h after exercise). All the procedures were double-blind and random. The haemoglobin O<sub>2</sub> saturation (SaO<sub>2</sub>%) was evaluated at the baseline and after 2h of exposure, whilst the serum concentration of HSP-70 was evaluated before entry into the chamber (baseline), after 2h of rest (pre-exercise), after exercise (post-exercise) and after 2h of recovery. Data normality was verified and descriptive analysis was performed by calculating the mean ± SE. Analysis of variance for repeated measures was carried out, followed by a Tukey post hoc test, and P-value = 0.05 was considered significant. The software Statistics 7.0 (StatSoft, Inc.) was used for the statistical analyses. In the exercise in hypoxia group, the SaO<sub>2</sub> decreased (p<0,05) relative to the corresponding values in normoxia. **Results** In the hypoxia and hypoxia+carbohydrate conditions, SaO<sub>2</sub>% decreased by approximately 10% after 2 h of exposure to hypoxia in relation to the baseline (before exercise.) The quantity of HSP-70 showed an increase from the baseline versus post-exercise (P = 0.0008), pre-exercise versus post-exercise (P = 0.0008), and pre-exercise versus after 2 h (P = 0.01) in the hypoxia+carbohydrate condition. **Discussion** The carbohydrate supplementation increased the concentration of HSP-70 after exercise and after 2h of recovery, suggesting that supplementation may stimulate the protective effects of cells mediated by HSP-70 in hypoxia. **Reference** Mazzeo RS. (2008). *Sports Med*, 38, 1-8. **Contact** alinecaris@hotmail.com **Financial support:** Fapesp: 2014/03237-4

### **METABOLIC FATE OF A FRUCTOSE LOAD INGESTED BEFORE OR AFTER EXERCISE**

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**Introduction** Overconsumption of fructose may promote hypertriglyceridemia in healthy sedentary subjects, possibly by targeting fructose carbons into de novo lipogenesis. This effect is largely prevented by exercise. To assess how exercise impacts fructose metabolism, we compared the metabolic fates of oral <sup>13</sup>C-labelled fructose loads (OFL) consumed a) in resting, non-exercising condition, b) before and c) after an acute aerobic exercise. We hypothesized that fructose ingested before an exercise session would be immediately oxidized, whereas fructose ingested after exercise would be mainly used to replenish glycogen stores. **Methods** 8 sedentary young males were studied on 3 occasions after 4 days on a weight-maintenance, high-fructose diet (30% daily energy needs as fructose). On the 5th day, they ingested an OFL (ie. 0.75g <sup>13</sup>C-labelled fructose/kg) either a) in resting condition (C), b) with a low to moderate aerobic exercise (FruEx; 60 min cycling at 100 W) starting 90 min after fructose ingestion, or c) with the same exercise starting 75 min before ingestion (ExFru). On each occasion, fructose oxidation (<sup>13</sup>CO<sub>2</sub>), non-oxidative fructose disposal (NOFD, defined as fructose ingestion – <sup>13</sup>C fructose oxidation, corresponding to net glycogen storage), conversion of fructose into plasma glucose (plasma <sup>13</sup>C-glucose kinetics), and plasma lactate and triglyceride (TG) concentrations were measured over 7 hours after fructose loading. **Results** Fructose oxidation was significantly higher in FruEx than in C (80 ± 3% OFL vs 49 ± 1% OFL; p<0.001), but was unaltered in ExFru (46 ± 1% OFL; p=0.14 vs C). Consequently, NOFD was significantly lower in FruEx than in C (20 ± 3% OFL vs 51±1% OFL; p<0.001) and in ExFru (54 ± 1% OFL, p<0.001 vs FruEx). The integrated incremental area under the curve of plasma TG were not significantly different (5.44 ± 20.58, 1.56 ± 24.98, and 1.09 ± 13.09

mmol/L\*420 min in C, FruEx and ExFru, respectively). Similarly, fructose conversion into glucose as well as plasma lactate concentrations remained unchanged in both FruEx and ExFru, as compared to C. Discussion Exercise performed after fructose ingestion stimulates fructose oxidation at the expense of glycogen storage. Preferential oxidation of fructose-derived glucose and lactate by working muscle is likely to be responsible for this effect. In contrast, exercise performed before ingestion does not significantly alter the metabolic fate of a subsequent fructose load. These results suggest that exercise, when performed immediately after fructose ingestion, may be essentially efficient at preventing adverse metabolic effects of fructose by targeting fructose carbons directly into oxidative pathways. This work was supported by the Swiss National Science Foundation. Contact: Jeremy.cros@unil.ch

## EFFECT OF LINCZI AND ELIXIR FENIX FOOD SUPPLEMENTS ON SPORTSMEN'S PHYSICAL AND FUNCTIONAL CAPACITY

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Aim was to determine the effect of food supplement LINCZI and elixir FENIX on physical and functional capacity of athletes to work in various energy production zones. Methods. Twenty-eight men were divided into two groups. I group subjects took the supplement LINCZI (0,5 g./day) and FENIX (30 ml/day) for 20 days. II group - consumed lactose as a placebo. The 1st testing was one day before the intake of food supplements and 2nd testing - three days after the intake of food supplements. We tested psychomotor reaction time, single muscle capacity and anaerobic lactic muscle power, anaerobic lactic-glycolytic muscle power and aerobic capacity; heart rate at rest, after standard physical load and after 60s recovery. Haemoglobin concentration and Haematocrit were determined. Results. Supplementation of LINCZI in combination with elixir FENIX for a period of twenty days effectively influenced anaerobic lactic-glycolytic muscle capacity, cardiovascular system capacity and aerobic capacity. VO<sub>2</sub>max increase from 42,64±3,69 till 49,68±4,94 ml/min/kg. Supplementation has not significant influences on athletes' single muscle capacity power, anaerobic lactic muscle power, CNS function, Haemoglobin and Haematocrit concentration. Discussion. We have found that food supplement LINCZI and FENIX has more influence on increasing anaerobic lactic-glycolytic muscle capacity and aerobic capacity. Kumar et al., (2011) reported, that Cordyceps Sinensis supplementation improves exercise endurance capacity of rats. The study Parcello et al., (2004) didn't show significant influence of supplements Cordyceps sinensis to VO<sub>2</sub>max elite women cyclist. While, Walker (2006) found, that of supplementation of Cordyceps sinensis effected results in running middle and long distance. Our study did not show significant increases in athletes' single muscle capacity and anaerobic lactic muscle power. Chen et al. (2012) examined lentinus edodes and found it's antioxidant capacities. References Chen H, Ju Y, Li J, Yu M. (2012). International Journal Of Biological Macromolecules, 50 (1), 214-218. Kumar R, Negi PS, Singh B, Ilavazhagan G, Bhargava K, Sethy NK. (2011). Journal Of Ethnopharmacology, 136 (1), 260-266. Parcell A, Smith J, Schulthies S, Myrer J, Fellingham G. (2004). International Journal of Sport Nutrition and Exercise Metabolism. 14 (2), 236-242. Walker T.B. (2006). Strength and Conditioning Journal, 28 (2), 21-23. Contact: ruta.dadeliene@gmail.com

## PHARMACOKINETICS OF ACUTE TYROSINE INGESTION AT REST

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Introduction Acute ingestion of tyrosine (TYR), a catecholamine precursor, has been shown to improve aspects of cognitive function and mood during exposure to stressful environments, in military and sport specific settings. Currently, there is limited research exploring the optimal dose of TYR relative to blood values, to prescribe pre-exercise or before exposure to a stressor. Therefore, the aim of this study was to investigate the effects of different TYR dosing strategies on serum TYR concentrations at rest. Methods Twenty-one healthy males were randomly allocated to one of three groups (n = 7 per group); HIGH (300mg/kg TYR in total), LOW (150mg/kg TYR in total) and CON (sugar free squash placebo). Ingestion of TYR/CON was double blinded and was administered in a drink form (dissolved in 250mL sugar free squash) in two separate doses at both 0900 and 1300. Participants consumed a standardized breakfast (0800) and lunch (1200) prior to consumption of TYR and remained in the laboratory from 0900-1700 having blood drawn every hour from a cannula. Blood samples were analysed via HPLC to assess TYR concentrations across all time points. Measures of blood pressure, gastric discomfort and perceived readiness to invest physical and mental effort (RTIPE/RTIME) were also recorded. Results Significant differences in serum TYR concentrations were observed between groups (P < 0.001), with the HIGH dose (399 ± 69 µmol/L) resulting in the largest elevation compared to the LOW dose (279 ± 76 µmol/L) and CON (64 ± 11 µmol/L). Ingesting TYR as a double-dose did not significantly increase the peak in serum TYR compared to the first dose in both groups; low (221 vs 273 µmol/L) and high dose (331 vs 368 µmol/L) (P > 0.05). No significant differences were observed in blood pressure, gastric discomfort, RTIPE or RTIME over time or between groups (P > 0.05). Discussion This study demonstrates that ingestion of a single dose of 150 mg/kg body mass-1 TYR may be sufficient to elevate serum TYR concentrations (350 µmol/L) and that the peak in TYR concentration typically occurs 2 h post ingestion (without the need for a second identical dose 4 h later). Furthermore, ingestion of this dose does not seem to influence perceived RTIPE/RTIME, blood pressure or induce gastric discomfort and therefore may be safely administered prior to a stressful encounter.

## THE EFFECT OF ENDURANCE EXERCISE AND RESISTANCE EXERCISE ON POSTPRANDIAL LIPEMIA

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Introduction Most studies were set to investigate the effect of acute endurance exercise on postprandial lipemia. There were limited studies investigating the effect of resistance exercise and endurance exercise on postprandial lipemia. Previous studies concluded that postprandial lipemia could be reduced after a acute endurance exercise. However, there is no consensus when it comes to resistance exercise. Methods Six recreationally trained men (aged 21.7±1.4 yrs) completed 3 experimental trials. Each trial lasted for 2 days and was separated a week apart. In order to rule out the effect of muscle damage, all the participants took two week recess after resistance exercise trial. On day 1 afternoon (4-5pm), the subject either took endurance exercise (50% VO<sub>2</sub>max walk), resistance exercise (ten kinds of resistance exercise, 12 RM, 2 sets) or rest (control). On day 2, after overnight fast, subjects were asked to consume the oral fat tolerance meals and were asked to rest for 6 hours. Venous blood samples were taken during fasting and 6 hours postprandial period. Result Endurance exercise significantly reduced the concentration of plasma triglyceride incremental area under the curve (IAUC) compared to control group (P=0.038). There were no significant differences on plasma insulin, glucose, Non-esterified fatty acid, glycerol, D-3-Hydroxybutyrate, high-density lipoprotein cholesterol, cholesterol, CK and LDH concentrations. Conclusions The current study suggested the endurance exercise significantly reduced postprandial lipemia when compared to control group. There was no significant effect of

resistance exercise on postprandial lipemia. References Burns, S. F., Broom, D. R., Miyashita, M., Ueda, C., & Stensel, D. J. (2006). MSSE, 38(3), 527-533. Burns, S. F., Corrie, H., Holder, E., Nightingale, T., & Stensel, D. J. (2005). J.Sports Sci., 23(3), 251-260.

### **ZEOLITE SUPPLEMENTATION AFFECTS INTESTINAL BARRIER INTEGRITY OF ENDURANCE TRAINED SUBJECTS, ACCOMPANIED BY ANTIINFLAMMATORY EFFECTS**

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 (1)Panaceo GmbH, A (2)Green Beat, A (3)Medical University, A (4)Dr Greilberger GmbH, A (5)Biovis Diagnostic, D (6)Lorenz & Petek Ltd, A (7)SportchirurgiePlus, A (8)University of Vienna, A

**Introduction** Zeolites are microporous, crystalline aluminosilicate minerals featuring three-dimensional channels and cavities. Their structure is formed by tetrahedra of AlO<sub>4</sub> and SiO<sub>4</sub> which are the basic building blocks for building these channels. Zeolites exhibit a negatively charged framework, which is counter-balanced by positive cations resulting in a strong electrostatic field on the internal surface. Natural zeolites are therefore able to bind toxins (adsorption) present in the body and release essential minerals (ion-exchange) into the body at the same time. In this study it was investigated whether supplementation with a natural zeolite could influence biomarkers of gut wall integrity in endurance trained individuals. **Methods** In a randomized, double-blinded, placebo controlled trial, 52 endurance trained men and women, similar in body fat content, non-smokers, 20–50 years, received 2g of zeolite per day for 12 wk. Stool and blood samples for determination of tight junction modulators Zonulin as well as antiinflammatory IL-10 were drawn at the beginning and the end of the study. Nutrition and physical exercise training were standardized before sample collections. For statistical analyses a 2-factor ANOVA was used. **Results** At baseline both groups showed increased stool zonulin and plasma IL-10 concentrations. After 12 wk zeolite supplementation stool zonulin was significantly ( $p < 0.05$ ) decreased in the supplemented group. IL-10 was increased with a trend ( $p < 0.1$ ) in the zeolite group. Zeolite supplementation exerted beneficial effects on gut wall integrity via modulation of tight junctions. This was accompanied by antiinflammatory effects in subjects undergoing chronic exercise training. We could also show that this natural zeolite did not affect serum Al concentrations when ingested over 3 months. **Discussion** It is suggested that zeolite modulated the zonulin system by interacting with intestinal bacteria. Further research is needed to explore mechanistic explanations for the observations in this study. Our observations could be of practical relevance for athletes under the perspective that an improved intestinal barrier reduces athlete's susceptibility to endotoxemia.

### **EFFECT OF 5-AMINOLEVULINIC ACID AND EXERCISE TRAINING ON HEMOGLOBIN MYOGLOBIN AND CYTOCHROME C OXIDASE LEVELS**

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**Introduction** Aerobic exercise is considered to prevent some diseases by using excess energy stored in the body. To make exercise more effective, quantity of oxygen transporting substances may be important. 5-Aminolevulinic acid (ALA) is a precursor of heme, and heme consists oxygen transporting substances such as hemoglobin, myoglobin and cytochrome c oxidase (COX). ALA is widely distributed both in plants and animal cells. Lately, ALA can be made relatively low cost. If ALA administration increases these oxygen transporting substances, exercise would be more effective to prevent the diseases. Therefore, in this study, we compared levels of hemoglobin, myoglobin and COX activity between the rats with and without ALA administration. **Methods** Three weeks old male Wistar rats were divided into 4 groups, sedentary (control), sedentary+ALA (Sed+ALA), exercise (Ex), exercise+ALA (Ex+ALA). Each group was consisted of 10 rats. ALA was dissolved in water and administered about 10mg/kg/day. Exercise rats swam 5 days a week. Swimming duration was 15 min at 3 weeks old, gradually increased to two hours. Blood hemoglobin concentration and soleus myoglobin concentration and COX activity were measured. Two-way ANOVA was used for statistical analysis. **Results** Body weight of both exercise groups were significantly less than the two sedentary groups. ALA administration decreased blood hemoglobin concentration when Ex and Ex+ALA compared. Myoglobin concentration in the soleus was not different among the four groups. Main effect of ALA was found. ALA administration increased COX activities. **Discussion** Body weight decrement in the Ex and the Ex+ALA groups proved that these rats trained well. Hemoglobin plays an important role in transporting oxygen from the lung to peripheral tissues and ALA is precursor of hemoglobin. So we had thought this value would increase but the result was opposite. This change does not necessarily reduce exercise ability because hematocrit also decreased in the Ex+ALA group. So blood flow was more smooth in the Ex+ALA group. Anyway, combination of exercise and ALA did not increase blood hemoglobin concentration. Exercise and ALA administration did not affect myoglobin concentrations in soleus. On the other hand ALA administration significantly increased COX activities in mitochondria. These results suggest that ALA administration affects some oxygen transporting substances. In conclusion, it is possible that ALA administration increases effectiveness of exercise for decreasing body weight. Further studies are necessary to understand effect of ALA administration in detail. **References** Ogura S, et al.(2011) "The effect of 5-aminolevulinic acid on cytochrome c oxidase activity in mouse liver", BMC Research Notes 4:66, Ishizuka M. et al. (2011) "Novel development of 5-aminolevulinic acid (ALA) in cancer diagnoses and therapy", International Immunopharmacology 11:358–365. Contact [suda@hum.fitech.ac.jp]

## **Philosophy and Ethics**

### **RESEARCH ON THE SPORTS ORDER IN THE PERSPECTIVES OF PHILOSOPHY**

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Base on the philosophy of Marxism, Rationalism, libertarianism and anthroposophy to analyze sports order and its processes of spontaneity, autonomously and self-discipline. Make clear the concept of order, self-discipline, spontaneity and autonomously, develop the principle and requirement of order, self-discipline, spontaneity and autonomously. This article argues that the sustainable development of sport must follow the principle that individual benefit and group interests should be united and coordinated. People needs to develop individual spontaneity, realize that the sports activities belong to oneself and people should take the responsibility by own self for the health and live self-discipline. People can participate the sports in order to keep fit and entertain them self autonomously. The government meets the needs of individual to enact the policy and use the power of administration reasonably so that the unity of individual and group interests can be making.

## Physical Education and Pedagogics

### VALIDATION OF THE ATTITUDE/MOTIVATION TEST BATTERY IN MEXICAN UNIVERSITY STUDENTS FROM FACULTY OF SPORT

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Introduction Learning English for professional purposes (EPP) is fundamental for students engaged in sports-related faculties. In fact, it positively affects their overall knowledge and cultural background, as well as it increases their professional opportunities as coaches, teachers, or future researchers (Cianflone and Coppolino, 2009). However, the association "English First" underlined that engagement in ESP classes and motivation towards learning it are low among Mexican university students. The aim of this study is to validate the Attitude/Motivation Test Battery (AMTB) assessing motivation towards learning English (Gardner and MacIntyre, 1993) in the Mexican context. Methods We selected 242 students attending the first semester at the Faculty of Sports Organization of Monterrey (Mexico), who filled in a previously created Mexican version of AMTB (Sandoval Pineda, 2011) during the first week of classes. Results Initial reliability analysis showed low scores (Cronbach's Alfa = .432). After removing contradictory items, the questionnaire showed good reliability (Cronbach's Alfa = .948). Structural modelling demonstrated the goodness of the structure of the instrument (NNFI = .988; CFI = .989; RMSEA = .054; GFI = .634), which was confirmed by Confirmatory Factorial Analysis as well. Discussion Mexican version of AMTB is a valid instrument and can be used to assess motivation towards learning ESP in Mexican students from the faculty of Sports Organization. In the future, this tool can help us better understand students' attitude towards English, consequently promote this important issue in a more efficient and individuality-attentive way. References Cianflone, C., and Coppolino, R. (2009). English for specific purposes and content teacher cooperation: report on a pilot project. *Eng Specif Purp*, 24(3), retrieved from <http://www.esp-world.info>. Gardner, R., and MacIntyre, P. (1993). On the measurement of affective variables in second language learning. *Lang Learn*, 43, 157-194. Sandoval Pineda, A. (2011). Attitude, motivation, and English language learning in a Mexican college context. Thesis dissertation. University of Arizona, United States.

### HEALTH AND PHYSICAL ACTIVITY OF TEENAGERS: SOCIAL AND PEDAGOGICAL ASPECTS

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Introduction The importance of a problem of research self-keeping behaviour of schoolboys is caused: first, special importance of the teenage period for all subsequent human life; second, presence of negative tendencies in a state of health of modern Russian schoolboys; the third, what teenagers represent potential productive work and populated resources of our country [1]. The purpose of research – revealing of the social and pedagogical factors promoting formation at teenagers self-keeping behaviour and healthy style of a life. Methods Research was carried out within the framework of realization of the international scientific program «Health Behaviour in School-aged Children» in Ural region during the period with 2010 for 2014 years at participation of schoolboys 11, 13 and 15 years (n=2000). During research it was used sociological, pedagogical, psychological methods, and also methods of the logic and mathematical analysis. Results During research it is established, that the level of physical activity of teenagers as a whole can be estimated as insufficient. On a regular basis are engaged in physical exercises during after-hour time of 4-6 times in a week and more than 39,8% of respondents, and 60,2% of respondents are not engaged in physical exercises. 41,7% of respondents are members sports секций, on a regular basis and is organized go in for sports, and 58,3% of respondents are not involved in the organized employment by sports. Teenagers use opportunities of productive leisure on fresh air insufficiently. The level of physical activity of girls is essentially lower in comparison with young men of one age. On a regular basis are engaged in physical exercises outside of school lessons of 48,0% of young men and 30,1% of girls, and in physical exercises with achievement of training effect of 26,9% of young men and only 9,8% of girls. Discussion / Conclusion The analysis of results of research testify to the following. First, health of teenagers has essential specificity of studying which essence consists that a self-estimation of health and its real condition is connected not so much to actual diseases, how many with biological, social and cultural circumstances. Second, it is necessary to recognize officially teenagers as group of risk and accordingly to them to concern. Measures on preservation and strengthening of health of teenagers should take into account social, pedagogical and psychological features of a life and activity of teenagers. Thirdly, the modern system of physical education of children and teenagers not to the full meets to showed requirements and requires innovative transformation. References 1. Zhuravlyova, I.V. Health of Teenagers: The Sociological Analysis / I.V. Zhuravlyova. – M.: Publishing House of Institute of Sociology of The Russian Academy of Science, 2002. – 240 p. Contact Fyodorov Alexander: [sportscience@mail.ru](mailto:sportscience@mail.ru); <http://www.sporteducation.jimdo.com>

### INVESTIGATION ON THE KNOWLEDGE AND THE NOTION OF JUNIOR HIGH SCHOOL BOYS ABOUT GIRL'S MENSTRUATION

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Introduction: It is important for boys and girls to understand each other during puberty. Many girl students were missing the opportunities of appropriate exercise which were needed for their body developments since some studies showed that more than 80% girls had tendencies to be absent from swimming lessons during their menstruation. Some studies showed boys' knowledge and consciousness about menstruation. However there are few studies that clarify what boys think about girl's menstruation and their menstrual life. The purpose of this study was to clarify the knowledge and the notion of junior high school boys about menstruation. Methods: We created original questionnaires survey to 54 boys from a junior high school. The teacher of health and physical education explained about our investigation to the boys. And we asked the boys who agreed with the purpose of our investigation to answer our questionnaire. The questionnaire had the following questions: Q1: Do you know what menstruation is? –Yes, No and not sure. Q2: How long menstruation lasts? Q3: What is your image of menstruation? Q4: What do you think of girls who join in the swimming lessons during their menstruation? Q5: Five true-false questions about menstruation and exercise. Results Q1: was 'Yes' (50.0%), 'No' (13.0%), 'not sure' (35.2%) and 'unanswered' (1.9%). Q2: was 'one day' (50.0%), 'two days' (3.7%), 'three days' (20.4%), 'four days' (3.7%), 'five days' (11.1%), 'six days' (3.7%), 'a week' (25.9%), 'more than a week' (14.8%). Q3: (multiple answers) was 'not sure' (40.7%), 'It's normal condition for women' (38.9%), 'It must be burden' (27.8%), 'It must be complicated' (20.4%), 'It's important' (14.8%), 'It's mysterious' (9.3%) et al. Q4: (Multiple answers) was 'It's up to them' (55.6%), 'No problem. They can swim' (27.8%), 'It's not good for their health. they should observe' (25.9%), 'It's not good for them

because the pool water is not clean enough for them' (13.0%), The menstrual bleeding will contaminate the pool so they should not swim' (5.6%), 'I don't want to swim with them for some reason' (5.6%) and 'others' (1.9%). Q5; the correct answered rates of three questions were clearly different by a school year. Discussion: In this study, we clarified boys' knowledge and notice about menstruation. It was obviously for boys to have not negative notice of menstruation and exercise. However they had little knowledge about menstruation in itself though they had had sexual education at class. Therefore it is necessary for them to provide more correct and useful information not only menstrual mechanism but also menstrual period and continuation days, the symptom with menstruation in their future.

### **AFTER-SCHOOL SPORTS IN NOTTINGHAM . A CASE STUDY.**

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This is a case study focused at three schools in Nottingham (UK): Southwark, Hyden (primary schools) and Djanogly City Academy (secondary school). We validated by experts a questionnaire and we conducted 178 with boys and girls, 9-16 years of ages. The questionnaire included questions about the after-school sports practice. SPSS (v.15.0.1) was use calculating frequencies. Results showed that 73% of students practice Sports after school. The most practiced sports are football, basketball, cricket, swimming, tennis and athletics. The main reason for the sports practice (40%) is to practice their Sports with their friends (social motivation). These data had shown similar un previous Studies conducted in the case study in a School from Barcelona (Spain) conducted by Franco-Sola (2011). Students also rate highly (38%) new learning about techniques and tactics sports (quality in the activity). The place where these sports are practiced in the school's facilities (85%). In relation to the families of the students surveyed, 42% of them plays sports compared to 58% who do not. The findings show that children and young people tend to play sports even if their parents do not. Colleges offering, organizing and facilitating spaces for sports. The main motivation of students for sport is social, therefore, want to feel part of the group of friends. As future research, we will collect qualitative data by focus groups.

### **PHYSICAL EDUCATION BASED ON EVIDENCE VERSUS PRACTICES BASED ON EVIDENCE**

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Aim: The Physical Education was defined the science of teaching and coaching in the cross-disciplinary sport science directory (ICSSPE, 2008, 2013; Declaration of Berlin 2013) It was preliminary study and want to analyze and to develop the Education Based on Evidence (EBE) and Practice Based on Evidence (PBE) paradigm. Methods The history research methods was used was by systematic examination and explanation of change PE teaching in the 3rd millennium . The historical evidences are based on the primary sources (originally documents, laws and international declaration, international position statement by archives, library or web based archives in first-hand accounts) and external criticism (to establish the authenticity of the sources); internal criticism (to establish credibility, consistency and accuracy- of sources Results The evidence-based practice or evidence was oriented at effectiveness (EBP). They was developed in the clinical practice from 1992 in according at Cochrane A.L. (epidemiology studies, 1972). The EBE and EBP were developed by the new neurological research , new technologies of investigation and the new sharing knowledge by internet data bank connection. The evidence-based practice (EBP) 'implies making decisions for the promotion of education by integrating the best available evidence with professional experience, features, status, needs, values and preferences of students that are compatible with the environmental and organizational context. The professional decisions was taken by theoretical studies, qualitative studies and quantitative studies selected on the basis of the effectiveness of sources.. (Hjørland, Birger, 2011) The research were empirical, controlled and randomized and analyzed by meta-analysis and review (Chambless, DL. 1998) The most effective practices were become interaction between: 1) instructional design (history of theoretical models and their progressive and systematic comparison); 2) education based on evidence (scientific collecting and documenting of experimental evidence) 3) educational evidence -based practices The Physical education based on evidence was become priority of teaching orientation as declared in the international PE ant Teacher research (Eurydice, 2013) and the perspective for the PE Teacher training (pre-service, in-service and long life learning) (Cazzoli, 2014) Reference Borms J. (2008). Directory of Sport Science – 5th Edition Featuring: a journey through time – The changing Face of ICSSPE. Berlin: ICSSPE, ISSN.: 1729-3227 UNESCO (2013). Declaration of Berlin – The Minister meeting at 5th International Conference of Ministers and Senior Officials Responsible for Physical Education and Sport (MINEPS V). Berlin 28-30 May 2013. Cazzoli S. Quality of physical education as sport science based on evidence, (Chapter, pp 174-182) in Scheuer C., Antala B., Holzweg (Editors) Physical education: quality in management and teaching Logos Verlag Berlin GmbH 2014 (Reviewed), ISBN 978-3-8325-3802-6, ISSN 1866-1653 p. 174-181

### **DEVELOPMENT OF EVALUATION SYSTEM AS A FEEDBACK TOOL FOR PEDAGOGICAL PROGRESS OF PHYSICAL EDUCATION TEACHERS**

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Using data from an Indian University we developed physical education trainee teacher's evaluations of teaching quality as a feedback tool for improvement of pedagogical techniques among trainee teachers. The objective focus on improvement in teaching practices among trainee teachers instead of being used for mere evaluation technique. The developed feedback tool through evaluation process of physical education trainee teachers comprise of five primary parameters (competencies): knowledge, class management, communication, appearance and effort along with identification of their secondary subsets through content analysis. The content of the tool have been tested, evaluated, revised and validated by scientific process. The correlation coefficient among the testers were calculated for stability reliability and rater reliability along with Cronbach alpha scores for internal consistency reliability, indicating positive results and suggesting that the prepared evaluation system can be highly beneficial in evaluating and improving the overall competency of physical education trainee teachers.

## THE INTERVENTION OF PHYSICAL EDUCATION TEACHERS TOWARDS STUDENTS WITH ADHD IN PRIMARY SCHOOL: A CASES STUDY

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Introduction The Attention deficit hyperactivity disorder (ADHD) is, together with the oppositional defiant disorder, the most frequently diagnosed disorder in school-aged children (August, G.J., Realmuto, G.M., McDonald, A.W., Hugeret, S.M. and Crosby, 1996). In this presentation we will show you the project design of our research and how will it works. The objectives are: to identify the behaviours patterns of students diagnosed with ADHD in Physical Education classes; to analyse the intervention from PE teachers to students with ADHD during Physical Education classes; and to describe the effects on behaviour because teacher intervention. Methods In this research we are using two different but compatible analytical instruments: 1. Direct non-participative observation instrument (field notes) will be used. 40-60 entire Physical Education sessions (1 hour each) will be observed (8-10 sessions / school). 2. Teachers' interview (8 PE teachers). The sample consisted of 8 PE teachers with an ADHD students in their class (diagnosis based on DSM -IV- TR), from primary schools from Barcelona (upper primary school, 9-10 years old). First results (observation) After analysing the literature and collected related information, has thought it necessary to observe a set of sessions to learn what kind of "behaviour" of students with ADHD are given in physical education classes observed. A total of 711 behaviours have been observed in 42 PE sessions, with an average of 16.9 behaviours per session. A part of that, in each behaviour observed, we register the PE teacher's intervention. The interventions were classified based on behaviour modification techniques (Labrador, Cruzado, & Muñoz, 1993). Discussion Personality of those diagnosed with ADHD is conditioned by this disorder. Symptoms of inattention, hyperactivity and impulsivity involve attitudes and behaviors which often turn into conflicts: disturbing classmates, inattentiveness, striking, insulting... The PE class is usually carried out in a particular context, in which each individual is expressed as he/she is: that is why students with ADHD are shown as they are. Currently, we are working with the results of the PhD. And we would like to show the rest of the research early. References August, G.J., Realmuto, G.M., McDonald, A.W., Hugeret, S.M. and Crosby, R. (1996). Prevalence of ADHD and co-morbid disorders among elementary school children screened for disruptive behavior. *Journal of Abnormal Child Psychology*, 23, 571-583. Labrador, F. J., Cruzado, J. A., & Muñoz, M. (1993). Manual de técnicas de modificación y terapia de conducta (14a ed., p. 910). Madrid: Ediciones Pirámide. Soler Prat, S., & Vilanova Soler, A. (2010). Investigación en educación física. In Colección formación del profesorado. Educación Secundaria. Educación Física: investigación, innovación y buenas prácticas. (pp. 25-42). Barcelona: Graó. Contact vilaroca86@gmail.com

## THE EXAMINE OF SELF-LIKING AND SELF-COMPETENCE LEVELS OF STUDENTS' WHO DO/DON'T SPORT AND EDUCATED IN POLICE ACADEMY BITLIS VOCATIONAL HIGH SCHOOL

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Introduction In order to professional succeed; self-competence is very important. The competence is socio-psychological behaviour emphasizes on beliefs about decides and motivation (ÇEVİK, 2010; Jeffreys, 2010). When we seek at this point, it can be important point for police-officers. At this study, we examined to find emphasize of sport on self-liking and self-competence. Because decide and motivation can be effected by sports (ÇETİNKAYA, 2013). Methods This study is a descriptive study. Descriptive models are past or present existing research approach aiming to describe the situation as it is there. Events of the research, individual or object, as defined in its own conditions and tried to be. Them to change in any way, affect the effort is not displayed. Known to have the desired thing and there. Importantly, it in an appropriate manner 'observing' was to determine (KARASAR, 2005). Sampling was created by university student who who Do/Don't Sport and Educated in Police Academy Bitlis Vocational High School. For study, Two-Dimensional Self-Esteem:Self-Liking/Self-Competence Scale was used. Significantly level was accepted as  $p < 0.05$ . To evaluation, independent sample t-test and one-way anova statistical tests were used. Results At the end of this study, According to tests scores, was found significant levels differential between do/don't sport students self-liking ( $t_{.05}=4,321$ ;  $p < 0,05$ ), self-competence ( $t_{.05}=5,518$ ;  $p < 0,05$ ) and was not found significant level differential between age groups self-liking ( $F=1,407$ ;  $p > 0,05$ ), self-competence ( $F=0,884$ ;  $p > 0,05$ ). Discussion In this study according to tests scores, Sport is very important for self-liking and self-competence on students. Another consequence, age does not lead to differences in self-liking and self-competence level. Even in the age of self-liking and self-competence levels of individuals, can not affect much the sport. References ÇETİNKAYA, E. (2013). ATIŞ BRANŞLARINDA YARIŞMALARA KATILAN ÜST SEVİYE ATIŞ SPORCULARININ KARAR VERME BECERİLERİNİN PERFORMANSA OLAN ETKİSİNİN İNCELENMESİ. (Master), Dumlupınar University, Kütahya. ÇEVİK, B. (2010). Müzik Öğretmeni Adaylarının Müzik Öğretimi Özyeterlik Düzeylerinin Bazı Değişkenler Açısından İncelenmesi. Paper presented at the International Conference on New Trends in Education and Their Implications, Antalya-Turkey. Jeffreys, M. R. (2010). Teaching Cultural Competence in Nursing and Health Care : Inquiry, Action, and Innovation. New York: Springer Pub. Co. KARASAR, P. D. N. (2005). Bilimsel Araştırma Yöntemi (15. ed.). Ankara: Nobel Yayın Dağıtım.

## THE CURRENT STATE OF PHYSICAL EDUCATION IN THE ISOLATED ISLAND AREA

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Introduction We showed result that is no difference between inland and isolated island area of physical fitness, until the junior high school from the higher grades at elementary school, although the physical fitness level of the children in the lower grades at school of an isolated island area is high. As this reason, we thought that a combined class of an isolated island affects physical fitness level of children. Therefore, the purpose of this study was to show clearly the current state of physical education in the isolated island area. Methods Investigation 1(questionnaire survey) We got cooperation from 9 schools (Elementary schools are 6, Junior high schools are 3.) in isolated island area and 79 schools (Elementary schools are 57, Junior high schools are 22.) in interior of Okayama and Okinawa Prefecture in Japan. We distributed the questionnaires to these schools. The questionnaire contents were 2 points, about the state of the physical education and the students taking the lesson. Investigation 2(interview survey) 7 schools (Elementary schools are 4, Junior high schools are 3.) in isolated island area of Okayama and Okinawa Prefecture in Japan volunteered for this study. We had the interview to the teachers. The interview contents were 3 points, about the state of the physical education, about difference between the physical education of isolated island area and inland, and about the careful idea at the physical education. Results and Discussion As a result of questionnaire survey, it was clarified that the physical education of targeted schools at island is carried out by a combined class, the competitive sense of students at island is low, and a teacher of island feels difficulty about the class contents and school facilities. And, we ob-



tained the following views from interview survey. Because there are few students, their motor skill is easy to improve, but the events and contents of the class are limited. Furthermore, the students in combined class has gap at the physique and the fitness level, so it isn't so easy to teach physical education. In conclusion, the school in island has few sport facilities. And there are combined classes that have different developmental stage. Therefore, the result of this study suggests that the physical education in isolated island area have to consider these factors. (The Ministry of Education, Culture, Sports, Science and Technology, Grant-in-Aid for Young Scientists (B) )

### **STUDY ON THE EVOLUTION OF SOMATIC PARAMETERS IN FEMALE STUDENTS FROM THE UNIVERSITY OF BUCHAREST PARTICIPATING IN THE "SPORT FOR HEALTH AND RECREATION" PROGRAM**

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Introduction Hippocrates and Galen claimed over 2000 years ago the existence of a close relationship between our locomotor skills and our physical and mental health. Even so, the conducted research shows that more than 50% of the students are sedentary and have an above-average weight. The purpose of this research is to underline the evolution of important somatic parameters as an effect of practicing systematic motoric activities during free time. Methods A number of 250 Students from the University of Bucharest took part in an ameliorative experiment during which they participated in one main Physical Education course and 3-4 courses for the "Sport for health and recreation" program in their free time every week. The latter program included aerobics, social dance, swimming and jogging. In order to correctly evaluate the efficiency of these activities on the experimental group, a control group that only preferred the activity from the main course was used. The evaluated somatic indicators were the height, the weight and the abdominal, hips and thighs areas. With the help of the obtained values it was possible to determine the Body Mass Index and the Body Adiposity Index, which were then statistically interpreted and represented graphically. Results The female students from both the experimental and control groups were able to improve their somatic indicators, amelioration which can be observed in the results from the final test. The experimental group had a considerable increase in score between the initial and final examination in all the tested indicators ( $p < 0,05$ ), in contrast with the witnessing group where the score increase between the initial and final examination was insignificant ( $p > 0,05$ ). Discussion Through these tests it can be estimated how much the independent variable has influenced the data obtained, thus generating the differences between the two final sport tests. I believe that this program which underwent experimentation through specific exercises aiming to improve the body shape was efficient. Making the students aware of their own morphofunctional state of the body can be one very important way of boosting their motivation of actively participating in the Physical Education courses. Moreover, this self-awareness can also enable them to practice different forms of physical activities independently. Youth mobilization should become a purpose in itself for teachers in order to make the new generations more physically active. References Bota, A. (2006), *Exerciții fizice pentru viața activă*, Ed. Cartea Universitară, București Colectiv DEFS (2013), *Curs Educație fizică*. Ed. Universității din București, București Morrow, J., Jackson, A., Disch, J., Mood, D., (2005), *Measurement and Evaluation in Human Performance*, Human Kinetics, Champaign Stoica A. (2009) *Îndrumar metodic de înot*. Ed. Universității din București, București ganciuoana@yahoo.com

### **ENGAGING AND EMPOWERING PRE-SERVICE TEACHERS IN PETE PROGRAM THROUGH PROBLEM BASED LEARNING AND EXPERIENTIAL LEARNING**

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Introduction The "pre-service teachers" professional development has been unprecedented attention in high education (Senne & Strand, 2009). The aim of this study will be employed Problem-based learning (PBL) and experiential learning theory (ELT) methodology as a means of engaging pre-service teachers on a physical education teacher education (PETE). Methods First, we will focus on their acquisition of skills and content relevant to their professions learning experience of "Knowledge", "Theory-Practice Relationships", "Professional Collaboration", "Critical Thinking" and "Self-Directed Learning". Second, understand their learning experience of teaching reflection behavior in PBL and ELT. All the participants are focus on 12 pre-service teachers in their teaching practical course in elementary school. This study ran over an academic year (18 teaching weeks) and will be designed around two teaching sessions per week: a classroom-based seminar (1.5 hours) involving the use of PBL scenarios and a practical-based session (2.5 hours) on a specific issue in PE. Results All the data will be collected from their discussion sheets, reflection journals, and learning depth interviews. And the manuscript analysis will be used NVivo10 qualitative data analysis software. The study found that the PBL and ELT can effectively develop pre-service teachers professional development in five themes of "Knowledge", "Theory-Practice Relationships", "Professional Collaboration", "Critical Thinking" and "Self-Directed Learning". And most of them can facilitate learn, improve learner develop deeper discussion of learning contents in PCK. Discussion This study also tries to focus on the functions and limitations of PBL and the application of PBL in pre-service teacher education (Hmelo-Silver, 2004; Askell-Williams, Murray-Harvey, & Lawson, 2007). In conclusion, through the exploration of documents and foreign experiences, I recommend the application of PBL in pre-service PE teacher education in the future. References Askell-Williams, H., Murray-Harvey, R., & Lawson, M. J. (2007). Teacher education students' reflections on how problem-based learning has changed their mental models about teaching and learning. *The Teacher Educator*, 42(4), 237-263. Hmelo-Silver, C. E. (2004). Problem-Based Learning: What and how do students learn? *Educational Psychology Review*, 16(3), 235-266. Senne, A., & Strand, B. (2009). PETE students' Knowledge of appropriate instructional Strategies and perceived of their high school physical education teachers. *Mo J Health, Physical Education, Recreation and Dance*, 19, 25-40. Contact [Wenyiwang1225@gmail.com]

### **PROJECT-BASED LEARNING IN PE. BENEFITS AND PROBLEMS**

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Introduction The project – as a more and more widespread study method – provides several advantages. Optimally, it makes students strive for acquiring knowledge as they are activated and motivated by their personal interests (Larmer and Mergendoller, 2010). In our methodological research we aimed at applying project-based learning in PE. Realizing the set educational target relied heavily upon students' ideas, independent activities and creativity. This process represented a new, unusual task not only for the students but maybe even more so for the professors conducting the experiment. Methods During the period between 2010 and 2014, 106 professors with the help of 106 classes each processed a certain subject matter in project system. The duration of the projects were 4-6 weeks with the

following stages: 1. Introductory stage: brainstorming, timelines, action plan, checkpoints; 2. Project stage: realizing project programs; 3. Final stage: project product, checking. The efficiency of the project work was assessed by measuring the advancement (motor and/or skill tests), and by interviewing the project managing professors about the potentials of the project as a way of organizing learning. Results The efficiency of curriculum processing were verified by adequate tests. Regarding the measured, established or observed parameters, the students achieved better results at the end of the project than at the beginning. The professors considered the project work interesting (98%) and useful (77%), and altogether 81 % of them would apply it in the future. According to them, the biggest strengths of the project were its activating effect on the students and its potentials for differentiating. On the school level, its benefit was subject-marketing. Weaknesses included organizational and project-technical matters: how to handle passive stages, how to select the adequate tests, the evaluation, and the problems of the co-thinking professor's role. Discussion The PE. project is definitely a suitable instrument for curriculum processing. The students increasingly engaged in motion games and other kinds of activities in the course of the project. As activities relating to other subjects and areas were introduced during the PE. lessons, unexpectedly, more students became interested. Differentiating became apparent as the tasks were shared and the various activities of the project ensured that many students could enjoy a sense of achievement. The whole process was characterized by the development of student independence, cooperative solutions and outside contacts (with non-school personnel). The students quickly identified themselves with the opportunities provided by the project as opposed to our colleagues who had a hard time. References Larmer J., Mergendoller J. R. (2010) Meaningful Work. V. 68 | Nr 1. 34-37. Contact hekler@mnsk.nyme.hu

## ALTERATION OF SPORT FACULTY STUDENTS' PERFORMANCE LEVELS IN TERMS OF SKILLS IN ATHLETIC THROWING EVENTS

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Introduction We study the alteration of the performance levels of college and university students considering the last 25 years. The reason of our survey was the significant negative change in athletic skills and subject requirements. Methods In the period of our survey we processed the performance of the entire substance which meant more thousands of sport faculty students. Considering the throwing events, we took the results measured and registered by the colleagues, who teach the subject, as a basis. We processed the data by applying the SPSS statistical program package. Beside the normal statistic index we made correlation calculation for examining the relation between athletic performance levels and motoric skills. We determined the significance in  $p < 0.05$ . Results Our study proved a significant drop in performance levels as well as in motoric skills. The setback of performance in athletic throwing events is the direct consequence of the drop in motoric skills. Discussion In our opinion students arriving from high school into university have very low bases in technical knowledge as well as in motoric skills. The setback of performance is the direct consequence of the changes in education structure and the reduced lessons of the subject. In 2012 daily sport lessons were introduced in elementary and high schools. It should effect better performance in motoric skills and athletic requirements. University students can compensate the reduced athletic lessons by the syllabus with more practice and individual processing of the subject. References 1. Harris, J. & Cale, L. (1998): Activity promotion in physical education. In Green K. & Hardman, K. (Eds.), Physical Education. A reader. Meyer and Meyer Sport. Aachen 116-134. 2. Eccles, J.S. & Wigfield, A. (2000): Schooling's Influences on Motivation and Achievement. Securing the Future: Investing in Children from Birth to College. In.: S.H. Danzinger, J. Waldfogel. (Eds), Russell Sage Foundation, New York, 53-181. 3. Bagoien T.E., & Halvari H. (2005): Autonomous motivation: involvement in physical activity, and perceived sport competence: structural and mediator models. Perceptual Motor Skills, 1, 3-24. 4. Lindner K.J. & Kerr J. (2001): Predictability of sport participation motivation from metamotivational dominances and orientations. Personality and Individual Differences, 30, 759-773. 5. Polgár T. (2006): Vergleichende Analyse von Sportgewohnheiten bei den Schülern der Grundschulen und Mittelschulen in Burgenland und Komitat Vas. [http://www.inst.at/trans/16Nr/14\\_2/polgar16.htm](http://www.inst.at/trans/16Nr/14_2/polgar16.htm) Contact koltai.miklos@mnsk.nyme.hu

## ALTERATION OF SPORT FACULTY STUDENTS' PERFORMANCE LEVELS IN TERMS OF SKILLS IN ATHLETIC RUNNING EVENTS

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Introduction We study the alteration of the performance levels of college and university students considering the last 25 years. The reason of our survey was the significant negative change in athletic skills and subject requirements (Armstrong, N., Welsman, J. Kirby, B, 1998. Bagoien, T.E, Halvari, H. 2005). Methods In the period of our survey we processed the performance of the entire substance which meant the population of more thousands of sport faculty students. Considering the running events, we took the results measured and registered by the colleagues, who teach the subject, as a basis. We processed the data by applying the SPSS statistical program software. Beside the normal statistic index we made correlation calculation for examining the relation between athletic performance levels and motoric skills. We determined the significance in  $p < 0.05$ . Results Our study proved a significant drop in performance levels as well as in motoric skills. The setback of performance in running events is the direct consequence of the drop in motoric skills. Discussion In our opinion students arriving from high school into university have very low bases at technical knowledge as well as in motoric skills (Harris, J. & Cale, L. 1998., Eccles és Wigfield, 2000). The setback of performance is the direct consequence of the changes in education structure and the reduced lessons of the subject. In 2012 daily sport lessons were introduced in elementary and high schools. It should effect better performance in motoric skills and athletic requirements. University students can compensate the reduced athletic lessons by the syllabus with more practice and individual processing of the subject. References Armstrong, N., Welsman, J. & Kirby, B. (1998): Aerobic exercise and physical activity patterns of young people. In Green K. & Hardman, K. (Eds.), Physical Education. A reader. Meyer and Meyer Sport. Aachen, 105-115. Harris, J. & Cale, L. (1998): Activity promotion in physical education. In Green K. & Hardman, K. (Eds.), Physical Education. A reader. Meyer and Meyer Sport. Aachen 116-134. Bagoien T.E., & Halvari H. (2005): Autonomous motivation: involvement in physical activity, and perceived sport competence: structural and mediator models. Perceptual Motor Skills, 1, 3-24. Contact: poti@mnsk.nyme.hu

## PHYSICAL EDUCATION SCHOOL IN BRAZIL - A CASE IN SANTA CATARINA

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**Introduction** Due to the territorial extension, the natural and cultural diversity, among other factors, Physical Education school in Brazil has different nuances and characteristics when compared to other countries. In this context, this study was conducted in a public school located in Costa da Lagoa, in Florianópolis, belonging to the state of Santa Catarina in southern Brazil. In this region children can only reach such a school by trail or by boat, with no roads. In addition, the physical conditions of its school and its surroundings are peculiar: it has no sports field; there is a grass field next door; there is a pond of great extension in front; and is surrounded by a nature reserve. Based on these considerations, the aim of this study, part of a broader research was to investigate how the physical education classes at the School of Costa da Lagoa occur. **Methods** This is a qualitative research, carried out by means of ethnography (Geertz, 1989). Therefore, the researcher lived for three months in the community of Costa da Lagoa, and followed the physical education classes during this period. The instruments used were: field notes, informal conversations and participant observation. The data were analyzed by means of triangulation of data. This study was approved by the Ethics Committee, UDESC, N. 701,067 / 2014. Results Even in circumstances as diverse, there are many possibilities of being worked the contents of Physical Education. Classes were observed with "slack line" between the trees, hiking on search of birds, stand up in the pond, football in a backyard with grass without pre-established demarcations, dance packed by nursery rhymes, among other possibilities. A coherent educational proposal to the context, with their children, time and space was found, which goes through the close relationship with the natural environment and its surroundings, and can bring positive resonances in the triad leisure, sport and sustainability. **Discussion** The possibility of following the routine of physical education in that particular context shows that there are several possibilities of working body culture with different activities and nature-related (Cornell, 1996). In addition, the exchange of teachers working in different contexts in the area of physical education can help strengthen the range of opportunities offered children in class, in the pursuit of building more humane and sensitive educational plan. **References** Cornell, J (1996) Play and learn from nature. London: Improvements. Geertz, C (1989) The Interpretation of Cultures. Rio de Janeiro: LTC. Contact alcyane.marinho@hotmail.com, mira\_nm@hotmail.com

## INFLUENCE OF INSTRUCTION WITH OR WITHOUT NUMERICAL VALUE ON THE GRIP FORCE GRADING.

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**Introduction** Several reports have investigated the ability of force grading under the condition that aimed force intensities were instructed with numerical number such as "30%", "50%". In the fields of physical education, however, teachers or coaches often use abstracted intensities without numerical value such as "strongly than half", "less than maximum". The purpose of this study was to clarify the influence of two conditions that instructed with numerical value and without numerical value on the force grading. **Methods** Thirty-nine subjects were participated in the experiment. Experiment was conducted in accordance with the Declaration of Helsinki. Subjects were instructed to exert their grip force under the two conditions, i.e. with numerical value condition (WN) and without numerical value condition (WoN). First of all, maximum voluntary contraction (max) of grip force was evaluated in each subject. In the WN condition, the instructed force were set to nine grades from 10%max to 90%max. In the WoN condition, the instructed force were setting six grades, i.e. slightly less than maximum, less than maximum, stronger than half, slightly stronger than half, slightly less than half, and less than half. Two trials were conducted in each intensity, and all trials were randomized. The Constant Error (CE) was calculated as indices the errors between the target force and the actual force in the WN condition. In the WoN condition, relative values against subject's MVC (%max) were calculated. For the statistical analysis, One-way ANOVA by means of intensity factor was conducted in each condition. Results In the WN condition, the significant difference was not observed in the instructed intensity next to each other from 20%max to 60%max ( $p > 0.05$ ). CE showed overshoot from 10%max to 50%max, and undershoot from 60%max to 90%max. In the WoN condition, the significant difference was not observed between "slightly less than half" and "less than half" ( $p > 0.05$ ). Other intensities showed significant differences against all intensities ( $p < 0.05$ ). **Discussion** The overshoot of CE at lower intensities in WN condition supported previous study. From the results of both conditions, it was suggested that the grip force grading was roughly at the intensities become less than 50%max. We had a hearing to subjects how intensities were they image. Average of their imaged intensities were about 40% at "slight less than half", and about 30% at "less than half". Thus, it was considered that subject could image their force intensities but couldn't achieve generating it. Teacher or coaches should pay attention to that phenomenon when they instructed force or exercise intensities without numerical value. Contact: hayamit@shinshu-u.ac.jp

## SPORT FOR ALL IN ANÁPOLIS: A PROGRAM TO BE FOLLOWED

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**Introduction** Physical inactivity is a public health problem that hovers over the country (Hobbs et al., 2014), concerning researchers to propose alternatives and public politics that promote physical activity. For this reason, encourage regular physical activity is a strategy to change this situation. Today, the literature emphasized that an individual who is physically active has the ability to do daily activities with vigor and alertness, without fatigue and still has enough energy to pursue leisure-time activities and prepare for emergencies that succeed, while minimizing the risk of acquiring opportunistic diseases (Hanifah et al, 2014). In addition to the physiological matter, the psyche is also very affected and relates personal identity with sports practice, and gender issues. The purpose of this study was to display in the recipients view the effects of a sport program called Sport for All in Anápolis-Go. **Methods** It was a cross-sectional study that included 3115 subjects aged between 11 and 70 years, who were participants in one of the 53 public spaces and/or partner spaces that developed activities of the Sport for All program in Anápolis (PST-Aps). The program coordination assembled an evaluation instrument consisting of three opened questions, and instructed the collaborative team, composed of three officials who regularly visited the program area, to apply this instrument to the program recipients during technical visits in the period of August to October 2014. The recipients were approached by the evaluator and those who agreed to answer the questions did it immediately. The data were registered by approximation of response and the pooled results were analyzed qualitatively. Results The program supplied a gap that existed in the past by creating opportunities of sports activities (soccer, futsal, handball, volleyball, basketball, athletics, judo, karate, capoeira, skate, wheelchair basketball and sitting volleyball) and physical activities (water exercise, gym work, dance, guided walk and road race) in regions where people live, avoiding large displacements which generate costs and avoid the participation. It was evident that young people occupy a good part of the free time from school involved in sports activities, reducing downtime which could be exploited by criminals

forming followers. It was noticed in the expression of many young assessed (27%) that the sport has raised them a personal identity, factor identified in the literature as salutary (GASTALDO et al 2011). Among adults and elderly, the satisfaction was great with the activities. Many of them highlighted the decreased on the use of medications, the improve on physical and psychological well-being, willingness to daily and working activities, and the creation of new social groups. Discussion It was evidenced in the recipient view that the Sport for All program in Anápolis was an action that effectively brought positive effects to the local community in physiological, psychological and social aspects, strengthening the evidence presented in the literature.

### EFFECTS OF AN OUT OF SCHOOL SPORT PROGRAM BASED ON THE PERSONAL AND SOCIAL RESPONSIBILITY MODEL TO ENHANCE POSITIVE YOUTH DEVELOPMENT

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Introduction Hellison's Teaching Personal and Social Responsibility Model (TPSR) (2003) emphasizes the need to teach, through sports and physical activity, values and behavior to increase the competencies that adolescents need to adapt successfully to the different challenges of life. This study examined the influences of participation in a 6 months extracurricular sport program (from January to June 2014) based on Hellison's Teaching Personal and Social Responsibility Model (TPSR) in adolescents' self-efficacy, pro-social behaviour and personal and social responsibility. Method Participants were 34 male adolescents between the ages of 14 and 16 years ( $M = 15,18$ ;  $SD = 0,728$ ) divided in two groups of 17 who played football as extracurricular activity in Alicante (Spain). Measures include Spanish versions of The Multidimensional Scales of Perceived Self-Efficacy (Bandura, 2001), Personal and Social Responsibility Questionnaire (Escarfi, Gutiérrez, Pascual & Llopis, 2010) and Prosocial Behaviour Questionnaire (Caprara & Pastorelli, 1993) were administered individually to each of the participants. Descriptive statistics are presented as means $\pm$ SDs. A one-way analysis of variance (ANOVA) with repeated measures was used to assess differences between the psychological variables. Results Adolescents participating in the intervention group of the TPSR Model showed higher levels in self-efficacy ( $F(2,824) = 0.444$ ,  $p = 0.000$ ), prosocial behaviour ( $F(2,118) = 0.687$ ,  $p = 0.016$ ) and personal and social responsibility ( $F(3,765) = 0.708$ ,  $p = 0.000$ ) than the comparison group. Discussion TPSR is an effective model for improving psychological and social skills in adolescents in out of school settings. Our current findings are consistent with those studies that implemented TPSR Model for improving fundamental areas of psychological and social development (Escarfi et al., 2010). Further research are needed with larger number of adolescents and explore, through longitudinal studies the long-term effects of the TPSR Model. References Bandura A. (2001) Social cognitive theory: an agentic perspective, *Annu Rev Psychol*, 52, 1–26. Caprara GV, Pastorelli C. (1993). Early emotional instability, prosocial behavior, and aggression: some methodological aspects. *Eur J Personality*, 7, 19–36. Escarfi A, Gutiérrez M, Pascual C, Llopis R. (2010). Implementation of the Personal and Social Responsibility Model to improve self-efficacy during physical education classes for primary school children. *IJP&PT*, 10 (3), 387–402. Hellison, D. (2003). Teaching responsibility through physical activity (2nd ed.). Champaign, IL: Human Kinetics.

### A BOWLER'S NARRATIVE INQUIRY OF FATHER'S SUPPORT

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Introduction Support from parents is considered as the most important resource that facilitates the development of elite athletes. The purpose of this study was to explore a bowler's training and competition process in addition to his father's life story of being multiple roles as a father, coach and sponsor more than 10 years. In 1999 after the innovate lane machine was sanctioned by the World Tenpin Bowling Association, the Taipei spinner bowling style was no longer glorious at international tournaments. This big change in bowling environment makes lots of teenagers switch from spinners to hook ball bowlers. The targeted bowler have been playing hook ball over 16 years and was interviewed to express his experience in how his father supported him to be an elite bowler. Methods The approach of narrative inquiry was used in this study. The participant was a bowler (aged 35) who had been a member of national bowling team over 16 years. Semi-structured in-depth interviews were implemented as the main source of data collection supplemented by the collection of relevant document such as photos, game results, trophies, awards of tournaments and dairy, etc. The combination of these data sources led the analysis of the story. Results The study showed the fact that during the process of being an elite bowler, his father played as multiple roles which provided him technical, mental, and financial supports. The story was narrated in three parts of his father's role: a father, a coach, and a bowling lover. Due to long term involvement in bowling sport, his father was viewed either as a spectator or a coach that both offered significant supports to the bowler. Discussion Psychological and financial supports from parents are highly related the development of young athletes' talent. To encourage adolescents to participate in competitive sport, parents' assistance is needed to let younger players get more resources and a better training environment. References Vella, S. A., Oades, L. G., & Crowe, T. P. (2010), The application of coach leadership models to coaching practice: Current state and future directions, *5(3)*, 425–434. Tan, B., Aziz, R., & Teh, K. C. (2000), *Journal of Science and Medicine in Sport*, 3(2), 176–185. Eccles, J. S. & Harold, R. D. (1991), *Journal of Applied Sport Psychology*, 3(1), 7–35.

### EFFECTS OF A DANCING PROGRAM ON THE SPATIAL CONCEPT OF KINDERGARTEN CHILDREN

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Introduction The development of children's spatial concept is created by personal self-orientation combining the impact of outer environment. The purpose of this study was to investigate the effects of a dance program on the spatial concept of kindergarten children. Method Eight children with the average age of 5 years old were recruited from a kindergarten as the participants of this study. The participants accepted a dancing program, featuring the coordination of body and eyes, for 3 weeks, 2 hours a week. A dance teacher graded the spatial movement performance before and after the dance program. At the spatial test, the children were required to recognize the directions and sides (right, left, up, down). Results The result indicated that the spatial movement performance was enhanced after the dancing program. However, two children were only observed a limited improvement in recognizing the directions because they strongly relied on their own reference system. Conclusion In the early stage of cognition development, dancing incorporating spatial components would be helpful for children to enhance their spatial concept. For dance instructors, the combination of body movement, voice guidance, and eye coordination within a dancing program is beneficial for children's development of spatial concept. However, a limited amount of children may not be easy to improve their spatial concept only through dancing. For these cases, it is important to help them develop a

more accurate reference system of directions by using another curriculum. References Poole, C., Miller, S.A., & Church, E.B. (2006). *Early Childhood Today* 20(6), 25-30. Hsiao-Hui Lin(2008), *Bulletin of Educational Psychology*, 39(4),533-544. Wen-Tung Hung(2011), *Journal of Meihu University*, Vol. 30 No. 1, 125-146. Lynnette Young Overby, Beth C. Post, Diane Newman .(2005). *IL, U.S.A ,Human Kinetics*, 303.

## Physiology

### **A WETSUIT PREVENTS BODY CORE COOLING IN COOL <22°C> WATER, WITHOUT CAUSING EITHER MARKED OR INSIDIOUS HEAT STRAIN IN COLD-TOLERANT SWIMMERS**

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**Introduction** Two threats facing endurance swimmers in open-water competition are hypothermia and autonomic conflict (Tipton & Bradford, 2014); each has several contributing factors that make it problematic to determine a safe minimal water temperature for these events. A minimum temperature of 16 °C is applied by FINA (wetsuits are prohibited), whereas the ITU prohibits wetsuit use only above 20 and 22 °C for elite and age group athletes, respectively, in short events (<=1500 m). Wetsuits provide buoyancy but can also be heat stressful. There are few studies to help inform these guidelines hence the purpose of this study was to test thermal responses in experienced open-water swimmers with and without a wetsuit in water of 22 °C. **Methods** Eight surf swimmers and triathletes (body fat 14 ±5%; range: 6 – 22%) consented to participate in this ethically-approved study. In a randomised crossover design, they completed two 1500-m flume swims (Streamlinz, New Zealand), with and without a 3-mm full wetsuit, on different days, after a 5-min warm up. Water and air temperatures were 22 °C and 21.4 °C, respectively. Core temperature (Tc) was measured in the oesophagus, to approximate right atrial temperature. **Results** Without a wetsuit, Tc fell in two swimmers, by 0.6 and 0.9 °C - reaching 35.3 °C in one - without notable cold discomfort (3 and 2, on scale 1 - 10). Tc rose in both when swimming in a wetsuit. For the group, Tc rose 0.6 ±0.6 °C more when wearing the wetsuit than not (0.8 vs 0.2 °C; P=0.03; ES=0.94); more so in those who were coolest without it (r=0.77). In two swimmers the Tc rose >1.0 °C without a wetsuit, but wearing a wetsuit had negligible additional effect on Tc (<0.3 °C) in these swimmers. In four swimmers the Tc rose >1.0 °C in a wetsuit, but they reported marked heat discomfort (rating 5+). Adiposity accounted for one third of the Tc response when not wearing a wetsuit, and almost none (1%) when wearing a wetsuit. **Discussion** Substantive core cooling can occur in lean swimmers over 1500 m in borderline (22 °C) water temperature when a wetsuit is not worn, though the typical response is a slight rise, as observed previously (Lowden et al., 1992; Trappe et al., 1995). A wetsuit prevented core cooling in this cohort, without causing an excessive rise. Most importantly, swimmers in this study demonstrated strong behavioural thermoregulatory cues against hyperthermia (when wearing wetsuits) that were not evident against hypothermia. **References** Tipton M, Bradford C. (2014). *Extrem Physiol Med*, 3-12 Lowdon BJ, McKenzie D, Ridge BR. (1992) *Aust J Sci Med Sport*, 24, 33–38 Trappe TA, Starling RD, Jozsi AC, et al. (1995) *Med Sci Sports Exerc*, 27, 1014–1021 Contact jim.cotter@otago.ac.nz

### **A STUDY ON SPINAL CORD MOTOR NEURONS AND NEUROMUSCULAR JUNCTION MORPHOLOGY IN OLD RATS**

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In the past, skeletal muscles were said to be innervated by motor neurons. However, the current authors found that changes in the morphology of the neuromuscular junction (NMJ) occurred in conjunction with increases and decreases in muscle activity, and these findings suggested that changes in the NMJ are regulated myogenically. **Objective** : Numerous studies have reported that morphological changes in the cell bodies of motor neurons in the spinal cord (MNsoma) and morphological changes in the muscle fibers they innervate are a factor for a loss of muscle strength in old age. The current study sought to ascertain the effect that morphological changes in muscle fibers and MNsoma had on the morphology of the NMJ in old age. In addition, this study examined the factors leading to changes with age. **Methods** : The laboratory animals used were 344 female Fisher rats (body weight: 280–330 g) that were 16 weeks old (the C group) and 2 years old (the 2Y group). MNsoma were labeled by injecting 10% horseradish peroxidase into the extensor digitorum longus (EDL) 12–24 hrs prior to removal of the spinal cord. The spinal cord was frozen and 40-µm serial transverse sections of the anterior horn of the spinal cord were prepared. Afterwards, the sections were stained with 3,3',5,5'-tetramethylbenzidine (TMB) and Nile red (NR). The muscle studied was the EDL. The EDL was frozen and then 50-µm serial transverse sections were prepared. Sections were stained with cholinesterase (ChE) and impregnated with silver and then the NMJ was identified. The MNsoma and NMJ were observed under a light microscope and measured with the software cellSens (Olympus). **Results and Discussion**: Differences in the surface area of MNsoma in the C group and the 2Y group were not noted. A previous study reported finding degeneration of the MNsoma in animals 2 and a half years old, though changes were not noted at 2 years of age. The 2Y group had significantly less skeletal muscle mass in comparison to the C group, and both groups had similar results in terms of the diameter of muscle fibers (fiber diameter or FD). Thus, muscular atrophy was found to have occurred in old age. The surface area of the motor endplate (endplate area or EpA) was significantly smaller, and the value of EpA/FD was smaller. A decrease in EpA greater than muscular atrophy (in percent) was noted. Microscopic images of the NMJ revealed evidence of abnormalities such as the loss of axon branches and axon terminals and the elongation of axon collaterals in atrophied muscle fibers. Results suggested that the loss of muscle strength in old age involves atrophy of muscle fibers, degeneration of the motor endplate, and degeneration of the NMJ. That atrophy and degeneration is then presumably followed by changes in the MNsoma.

### **EFFECT OF DIFFERENT WEIGHT LOSS PERIOD ON THE DEHYDRATION STATE IN WRESTLERS**

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**Effect of different weight loss period on the dehydration state in wrestlers** Mio Nishimaki<sup>1</sup>, Hiroki Tabata<sup>1</sup>, Hyeon-Ki Kim<sup>1</sup>, Karina Ando<sup>1</sup>, Mi Xiang<sup>1</sup>, Masayuki Konishi<sup>2</sup>, Shizuo Sakamoto<sup>2</sup> <sup>1</sup> Graduate School of Sport Sciences, Waseda University (Tokorozawa, Japan) <sup>2</sup> Faculty of Sport Sciences, Waseda University (Tokorozawa, Japan) **Introduction** Many wrestlers undergo extreme dieting with-rapid weight loss and fluid restriction, so that their weight is below the rule weight, as measured before a match (Artioli et al.,2010). Rapid weight loss with intense training and food / fluid intake restrictions could be extreme stressor to our ability to adapt to stress. This stress is thought to be induced body dysfunction such as exsiccation, hypoglycemia, regulation of body temperature functional decline, and reduced immune

function (Celeste et al., 1998). Rapid weight loss of short-term in wrestler is especially accompanied by dehydration due to sweating. In this case, it has been reported that such changes hematocrit increases (Triplette et al., 2010). About 70% of the wrestler had performed weight loss within 7 days (Aizawa et al., 2007). There is a need to compare the weight loss period. The aim of this study was to investigate the effect of different weight loss periods on the dehydration of wrestlers. Methods Six university student wrestlers (weight: 65.7±7.4kg) were participated in this study, and they have experienced rapid weight loss many times. All subjects completed three trials with different periods of rapid weight loss (seven days, three days, and one day) separated by more than 4 weeks. Each wrestler's body composition, hematocrit as an index of dehydration, visual analog scale responses (subjective fatigue, thirst, and hunger), and maximal oxygen consumption (Takagi et al., 2013) were measured at three time points: before weight- loss, at weigh- in, 12 hours after weigh- in. These measurements were compared across weight loss periods. Results No significant differences were found in hematocrit and visual analog scale maximal oxygen consumption in relation to different weight loss periods. Discussion&Conclusion The present results indicated that dehydration and maximal oxygen consumption were not affected by different weight loss periods. References Artioli, GG, Gualano B, (2010). *Medicine and Science in Sports and Exercise*. 42(3), 436-442 Celeste, W, (1998). *Medicine and Science in Sports and Exercise*. 30, 746-749 Trepette, J, (2010). *Am J Physiol Heart Circ Physiol*. 299 (3), H908-14 Aizawa, K, (2007). *Japanese Journal of Clinical Sports Medicine*. 15(1), 41-47 Takagi, S, Sakamoto, S, (2013). *Journal of Sports Sciences*, 32(2), 175-182 Contact Email: Imionishimaki@fuji.waseda.jp

### TIME COURSE OF HEAT ACCLIMATION, DECAY AND RE-ACCLIMATION IN ELITE LASER SAILORS PREPARING FOR A WORLD CHAMPIONSHIP EVENT IN HOT CONDITIONS: CASE STUDY USING A REAL WORLD MODEL

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Aim: To determine the time course of decay and re-induction of heat acclimation and its effects on aerobic fitness parameters in elite sailors preparing for the World Championships in Muscat, Oman. Methods: Two elite laser class sailors ( $VO_{2max} = 5.05 \pm 0.35$  L/min) completed 5 consecutive days of heat acclimation (HA) ( $T_a = 35^{\circ}C$ , 60% RH). A heat response test (HRT) was performed at baseline and 5 of HA, then on the 7th (Decay 1) and 14th (Decay 2) day following HA. Participants were then re-acclimated (RA) for 2 days, followed by a final HRT ~72 h post-RA. Rectal temperature, skin temperature, heart rate, sweat rate, as well as thermal comfort and sensation were measured during each HRT. Changes in plasma volume and the power-to-heart rate ratio (P:HR) during sub-maximal cycling in the heat were monitored weekly for the duration of the study; the P:HR in thermoneutral conditions (~19°C, 50%RH) was measured during decay and RA. Results: Physiological and performance responses were similar for both sailors. Mean rectal temperature during the HRT was lowered from baseline ( $37.60 \pm 0.26^{\circ}C$ ) to day 5 of HA ( $37.14 \pm 0.29^{\circ}C$ ), and remained lowered through decay and RA (Decay 1 =  $37.26 \pm 0.27^{\circ}C$ ; Decay 2 =  $37.31 \pm 0.27^{\circ}C$ ; RA =  $37.29 \pm 0.26^{\circ}C$ ). Plasma volume showed minimal increases at day 5 HA ( $1.3 \pm 1.8\%$ ), but increased incrementally each week following (Decay 1 =  $3.4 \pm 1.1\%$ ; Decay 2 =  $8.1 \pm 1.3\%$ ; RA =  $15.5 \pm 1.1\%$ ). The P:HR, improved (11.0%) in the heat from day 1 to 5 of HA, then remained at a similarly elevated level at Decay 1 (7.4%) and Decay 2 (11.6%), then increased (19.9%) further after RA, compared with baseline values. Similarly, the P:HR in thermoneutral conditions improved (7.7%) from Decay 1 to RA. Conclusion: HA increased heat tolerance and the decay of these adaptations were minimal. Plasma volume and the P:HR progressively improved throughout the 4 weeks and were likely related to the combined heat and endurance training regime.

### THE EFFECT OF SHORT-TERM STRETCHING EXERCISE ON THE PROPERTY OF MUSCLE-TENDON UNIT

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Introduction Static stretching is often used in sports and rehabilitation field to improve flexibility. Many studies reported the effect of stretching training on muscle property, however, few studies have examined the acute effect of stretching. The purpose of this study was to investigate the acute effect of short-term stretching exercise on the property of human gastrocnemius muscle-tendon unit. Methods Healthy male subjects carried out static dorsiflexion stretching exercise for successive 3 days. They were standing on the stretch board in 1 min x 5 sets x 3 times/day x 3 days. Between the 1min stretching, they had 1 min intervals with standing on the floor. The ankle angle of stretching exercise was determined as a comfortable joint angle that could be maintained for at least 1 min. Before and after the 3 days of stretching exercise, the maximal passive range of motion, passive plantarflexion torque, maximal voluntary contraction (plantar flexion torque), muscle fascicle length and displacement of myotendinous junction were measured. The subject kept supine position with their right leg extended and right foot secured by the straps to a footplate. Muscle fascicle length was measured by using B-mode ultrasound from medial gastrocnemius muscle at rest and during passive stretching condition. Results and Discussion After 3 days of stretching exercise, the passive range of motion of dorsiflexion increased significantly ( $p < 0.05$ ). The passive plantarflexion torque at the certain ankle joint angle (pre maximal range of motion) and the maximal plantar flexion torque showed decreasing trend after stretching exercise, but they were not significant. The fascicle length in both rest and stretching conditions did not change significantly after stretching exercise. The stretching reduced the passive torque in acute effect (McNair et al, 2001). In this study, 3 days stretching exercise could change the joint range of motion. However, it could not change the passive torque in identical ankle joint angle. In conclusion, the results indicate that the short-term successive stretching exercise increases the joint flexibility without changing the maximal voluntary contraction torque and fascicle length. References McNair PJ, Dombroski EW, Hewson DJ, Stanley SN. (2001). *Med Sci Sports Exerc*. Contact muraoka@ge.meisei-u.ac.jp

### ELEVATED TEMPERATURE ACCELERATES RECOVERY OF MOUSE AND HUMAN SKELETAL MUSCLE FOLLOWING FATIGUE

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Introduction This study was designed to determine whether elevated muscle temperature allows muscles to recover their force or power more rapidly following fatigue. Methods Intact single fibers from mouse flexor digitorum brevis muscle were fatigued at 31°C (70-Hz 350-ms tetani once every 10 s until initial force decreased to 30%). During a subsequent 2-hr recovery period, the fibers were perfused in Tyrode solution at either 31°C (physiological temperature) or 36°C and isometric force and cytoplasmic free  $[Ca^{2+}]_i$  ( $[Ca^{2+}]_i$ ) were measured during 30-Hz tetani evoked periodically. In addition, seven human subjects performed fatiguing arm exercise consisting of 3 x 5min maximal effort arm cycling at 100 rpm followed by 4 x 15 min at an intensity of 50% of  $VO_{2peak}$ . Then followed 2 hr of recovery during which both arms were either heated or not heated at 5°C above physiological temperatures using arm cuffs continuously perfused with

temperature-regulated water; the order of heating vs. not heating was randomized between two visits. Intramuscular temperature was recorded with probes inserted 1.5 cm into the lateral head of the triceps brachii muscle. During the recovery period, subjects consumed 1.0 g/hr/kg body weight carbohydrates to support glycogen repletion. After recovery, the subjects repeated the 3 x 5 min time trials to evaluate the effect of the recovery intervention. Results Recovery from fatigue in mouse single fibers was dependent on muscle glycogen restoration since fibers perfused with glucose-free Tyrode did not recover contractile force ( $P < 0.05$ ). After 30 min of recovery, the tetanic  $[Ca^{2+}]_i$  was  $107 \pm 10\%$  and  $92 \pm 8\%$  and the corresponding forces were  $69 \pm 15\%$  vs.  $49 \pm 14\%$  of the initial values for the heated and non-heated muscles, respectively. In seven human subjects, 2 hr of muscle heating also appeared to improve muscle recovery, leading to higher mean power output in the post-recovery arm cycling time trial than without muscle heating. Discussion Elevating muscle temperature by  $5^\circ C$  above physiological temperature accelerates recovery in mouse muscle in-vitro and in human skeletal muscle in-vivo and this appears to depend on faster muscle glycogen resynthesis following fatigue.

### ENDOTHELIAL FUNCTION IN HIGH SCHOOL FEMALE RHYTHMIC GYMNASTS: IMPACT OF PSYCHOSOMATIC STRESS AND MENSTRUAL STATUS

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Introduction: Endothelial function is associated with progression of atherosclerosis and endothelial dysfunction predicts development of coronary heart diseases. Increased psychosomatic stress and estrogen deficiency associated with menstrual disorder impair the endothelial function. The endothelial function is suppressed in young female endurance athletes with menstrual disorder 1). However, no studies have examined the endothelial function in high school female rhythmic gymnasts, high risk group for the menstrual disorder. Purpose: The aim of present study was to determine the effects of psychosomatic stress and menstrual status on endothelial function in female high-school rhythmic gymnasts. Methods: Twenty-five high school female rhythmic gymnasts (age;  $16.4 \pm 0.9$  yrs, mean  $\pm$  SD) participated in a cross-sectional study. They were separated into two groups based on their competitive ability: Athlete (ATH) group ( $n=13$ ); rhythmic gymnasts who participate in national tournament for high school students in Japan, Recreation (REC) group ( $n=12$ ); rhythmic gymnasts who enjoy rhythmic gymnastics recreationally. Endothelial function was determined as flow-mediated vasodilation (FMD) measured by high frequency ultrasound in the brachial artery. Profile of Mood States (POMS) and saliva cortisol levels were used to measure psychological and physiological stresses, respectively. A formal interviews regarding menstrual status was conducted, and menstrual disorder was defined as the status including oligomenorrhea, secondary amenorrhea and delayed puberty. Results: The normalized %FMD (relative peak diameter increase normalized to the area under the curve of shear rate with hyperemia) was significantly lower in the ATH group ( $0.112 \pm 0.057$  A.U.) than in the REC group ( $0.189 \pm 0.098$  A.U.). Scores of "Anger-Hostility (A-H)" and "Fatigue (F)" of POMS were significantly higher in the ATH group (A-H;  $48.4 \pm 7.9$ , F;  $48.5 \pm 9.0$  points) than in the REC group (A-H;  $41.4 \pm 3.5$ , F;  $42.1 \pm 5.9$  points), and the scores of A-H was negatively correlated to normalized %FMD ( $N=25$ ,  $r=-0.416$ ,  $p < 0.05$ ). Saliva cortisol levels tended to be higher in the ATH group than in the REC group ( $p=0.050$ ). Menstrual disorders were seen with a higher frequency in the ATH group (84.6%) than in the REC group (25.0%). However, there were no difference in normalized %FMD, scores of POMS and saliva cortisol levels between subjects with normal or disordered menstrual status. Conclusion: These results revealed that the higher psychosomatic stress but not presence of menstrual disorder may be involved in impaired endothelial function in high school female rhythmic gymnasts. Reference: 1) Rickenlund, A. et al., J Clin Endocrinol Metab 90(3), 2005.

### CELL-FREE DNA DURING INTERMITTENT VS. CONTINUOUS STEP-WISE PROGRESSIVE RUNNING INTERVALS

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Introduction: Different types of running exercises have been shown to increase the concentrations of circulating cell-free DNA (cfDNA) (1,2). Little is known about the influence of type and intensity of exercise on cfDNA levels. Here we examined the influence of intermittent versus continuous step-wise progressive treadmill running on cfDNA concentrations. Methods: Thirteen male handball players and 13 hobby-triathletes performed two different step-wise progressive treadmill running tests applying spirometry and lactate measurements. First, we employed a classical protocol starting at 6 km/h increasing 2 km/h every 3 min determining an individual anaerobic threshold (IAT) (1) and an intermittent protocol consisting out of intervals with a slow 15 sec. component remaining constant at 6 km/h, and a fast 15 sec. component starting at 8 km/h and increased by 2 km/h every 3 min. Capillary and venous samples were collected before and directly after exercise. cfDNA was measured by direct quantification from unpurified plasma using a real-time qPCR assay. Results: Type of sports was neither associated with significant differences in  $VO_{2max}$  or IAT and did not have an influence on any of the following reported associations. Average speed at exhaustion was 16.0 km/h for continuous tests and 13.6 km/h for intermittent tests with a respective approximated fast interval component of 21.2 km/h. Lactate at exhaustion and  $VO_{2peak}$  were not different in intermittent versus continuous exercise testing, while venous cfDNA concentrations were significantly 1.48-fold higher (CI: 1.14-1.93,  $p < 0.01$ ) and capillary values 1.58-fold higher (CI: 1.19-2.09,  $p < 0.01$ ) following the intermittent protocol. Total energy expenditure was 1.22-fold higher (CI: 1.13-1.31,  $p < 0.001$ ) for intermittent testing. Discussion: The intermittent protocol was associated with significantly higher cfDNA increases, while  $VO_{2peak}$  and lactate did not differ between exercise protocols. Potential reasons for the higher cfDNA levels could be the higher duration and higher energy expenditure during the intermittent protocol. Energy expenditure has recently been shown to be a factor associated with cfDNA increases (1). The precise factors associated with cfDNA increases remain to be elucidated in order to evaluate its full potential as an exercise marker. Literature: 1 Breitbart S, Sterzing B, Magallanes C, Tug S, Simon P. (2014). Direct measurement of cell-free DNA from serially collected capillary plasma during incremental exercise. J Appl Physiol 117: 119–130, 2 Beiter T, Fragasso A, Hudemann J, Niess AM, Simon P. (2011) Short-term treadmill running as a model for studying cell-free DNA kinetics in vivo. Clin Chem 57: 633–636,

### THE ACUTE AND PROLONGED CHANGES IN VASCULAR FUNCTION IN RESPONSE TO ENDURANCE AND RESISTANCE EXERCISE TRAINING

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Introduction: The impact of exercise training on vascular function has been well studied. However, little is known about how acute exercise-induced changes in vascular function relate to exercise training, and whether this depends on the type of exercise. Therefore the aims of this study were to 1) examine the acute (single bout) and chronic (4 weeks) changes in vascular function to endurance (ET) versus

resistance training (RT), and 2) examine the relationship between acute changes in vascular function in response to a single bout of exercise and chronic changes following 4-weeks of exercise training. **Methods:** Using a randomised cross-over design, seven male subjects (age:  $21 \pm 3$  yr, weight:  $73 \pm 9$  kg, height  $177 \pm 4$  cm) were assigned to 4-week ET and RT (randomly ordered) exercise training program (3 sessions per week), with a washout of 6 weeks. Vascular function was assessed using flow-mediated dilation (FMD), both before and immediately after the first exercise bout and after 4-weeks training. **Results:** Following an acute bout of exercise, we found a significant increase in FMD (main effect 'time':  $P=0.041$ ), which was not significantly different between both types of exercise (interaction-effect:  $P=0.11$ ). Brachial artery FMD following an acute bout of resistance exercise increased from  $7.4 \pm 2.2\%$  to  $10.6 \pm 3.6\%$ , whilst endurance exercise caused an immediate increase in  $6.7 \pm 1.8\%$  to  $7.1 \pm 2.0\%$ . We found no significant changes in FMD following the 4-week exercise training in either group (main effect 'time':  $P=0.12$ ,  $7.4 \pm 2.2\%$  to  $8.36$  for resistance training and  $6.7 \pm 1.8\%$  to  $8.7 \pm 3.1$  for endurance training). There was no significant correlation between acute changes in FMD after a single bout of exercise and exercise training-induced changes in FMD ( $r=0.09$ ,  $P=0.75$ ). **Conclusion:** Our data suggest an acute improvement in vascular function following an acute bout of 30-minute exercise, independent on the type of exercise. Despite these immediate changes in vascular function, we found that 4-weeks endurance or resistance exercise training did not alter vascular function. Moreover, the acute changes in vascular function did not relate to the change in vascular function after 4 weeks. These data suggest that adaptation to 4 week exercise training, both after endurance and resistance exercise, cannot be simply explained through examining acute changes in vascular function to a single bout of exercise.

## THERMOREGULATION IN ENDURANCE TRAINED ADULTS

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**THERMOREGULATION IN ENDURANCE TRAINED ADULTS** Galán-Carracedo, J. 1,2, Suárez, A.2, Guerra-Balic, M. 1 1: FPCEE-Blanquerna, Ramon Llull University, Barcelona (Spain) 2: Corporació Mèdica Catalana, Cornellà (Spain) **Introduction** Thermoregulation is the ability of an organism to keep its body temperature (BT) within certain values, even when the environmental temperature is very different. The BT is related to metabolic activity and external environment conditions. The internal thermoregulation process is one aspect of homeostasis, which involves seeking homeothermic control. Many studies show how muscle activity increases our temperature due to metabolic heat production, and the importance of preventing hyperthermia. Any tendency to hypothermia ( $BT < 35^\circ C$ ) can also cause cardiovascular disorders and exhaustion, becoming one of the main metabolic factors leading to fatigue in trained subjects. The aim of this study was to determine the evolution and the effect of BT in trained adults of endurance sports during a progressive increasing treadmill running test. Our intention was to observe if there is a characteristic pattern of temperature behavior among individuals with better functional capacity. **Methods** Ten trained adults of endurance sports (age=  $38,55$ ,  $SD= 7,08$  years), previously familiarized with the experimental procedures, performed a progressive increasing treadmill test with a constant environment temperature of  $24^\circ C$ . During the test, BT was obtained with axillar digital thermometer High-Speed (Microlife), while fatigue level was also obtained through Borg's RPE scale. A 6 minute warm up period at  $6-8$  km/h was performed. The test began at  $8$  km/h with increments of  $1$  km every 2 minutes, until exhaustion, and  $10'$  of recovery. The treadmill slope was constant at  $1,5\%$ . BT of each participant was obtained at basal time, at the end of the warm up, at the end of the testing and during the  $5'$  and  $10'$  of the recovery period. Descriptive for all variables were calculated, and non-parametric Wilcoxon matched pairs test was applied to compare the differences of the BT between phases. **Results** Mean temperatures at basal phase, end of warming up, end of testing and recovery  $5'$  and recovery  $10'$  were  $35,9^\circ C$ ,  $35,8^\circ C$ ,  $35,5^\circ C$ ,  $36^\circ C$  and  $36,1^\circ C$ , respectively. The mean BT present significant differences decreased at the end of the warm up and at the end of the test comparing basal data ( $p < 0.01$ ;  $p < 0.02$  and  $p < 0.005$ ), just when exhaustion appeared. **Discussion** Results showed a decrease of BT when exhaustion appeared in trained adults of endurance sports, associated to fatigue. Endurance high intensity training could improve the metabolic response and thermoregulation of individuals. More research is needed.

## THE EFFECT OF INSULIN ON HEART RATE VARIABILITY AT REST AND DURING SUBMAXIMAL EXERCISE

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**Introduction** The purpose of the study was to investigate the effect of insulin on heart rate variability (HRV) at rest and during submaximal exercise **Methods** Ten healthy male subjects ( $23 \pm 1$  yr) performed in different days 20 min of cycling at  $35\%$  HRR, with and without ingestion of  $200$  g of glucose (maltodextrin). Capillary blood glucose concentration was measured by fingerstick at rest, 20 min following glucose ingestion and every 5 min during exercise. Plasma insulin was calculated from the blood glucose measurements using the Glucosafe model (Pielmeier et al. 2012). Heart rate (HR) was measured noninvasively (Finometer) during all trials and RR intervals were processed by fast Fourier transform (FFT) for determination of low-frequency (LF,  $0.045-0.15$  Hz) and high-frequency (HF,  $0.15-1.0$  Hz) components. **Results** Plasma insulin was higher at 0 min ( $P < 0.001$ ) and 5 min ( $P < 0.001$ ) during exercise with glucose supplementation compared to baseline. Furthermore, there was higher plasma insulin between the first three measurements; 0 min, 5 min and 10 min ( $P < 0.05$ ) during exercise with- compared to exercise without glucose supplementation. The LF and HF components expressed as absolute power ( $ms^2$ ) decreased significantly at the onset of exercise ( $P < 0.05$ ) but there was no difference between the two conditions at any time interval during exercise. The LF/HF ratio was not different with and without glucose supplementation, or during exercise and rest. **Discussion** There was no effect of plasma insulin on HRV at rest and during submaximal exercise. **References** Pielmeier et al. (2012). *J Clin Monit Comput* 26:319-28 Contact Svolian@hst.aau.dk

## PERIPHERAL AND CENTRAL EFFECTS OF SMOKELESS TOBACCO ON EXERCISE ENDURANCE IN MEN

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**Introduction** A proliferation of nicotine use in the sport environment has been observed in recent years mainly as smokeless tobacco (Zandonai et al., 2013). Nicotine has been listed in World Anti-doping Agency's Monitoring Program from 2012 to 2015 in order to detect potential patterns of abuse. The aim of this study was to investigate the effects of Snus (SS), an oral smokeless tobacco, on the perception of fatigue during aerobic exercise to TTE. **Methods** The study was a double-blind placebo controlled (SP) crossover design. Fourteen healthy male non-smokers were recruited. Subjects were studied during three sessions on cycle-ergometer: experimental session 1 (Exp1) consisted in an incremental exercise test to determine maximal aerobic power (Wmax); Exp2 and Exp3 consisted in exercise at  $65\%$



Wmax until exhaustion in SS or SP conditions. During the Exp2 and Exp3, muscle and cerebral oxygenation by means of NIRS (near-infrared spectroscopy) and global rating of perceived exertion (RPE) were recorded. Before and after all experiments, the Profile of Mood of State questionnaire (POMS) was administered to subjects. Subjects were then tested by means of Transcranial Magnetic Stimulation (TMS) to assess changes in cortico-motor excitability due to the prolonged exercise. Results Time to exhaustion (TTE) was not significant difference ( $64.4 \pm 41.5$  min SS;  $51.6 \pm 17.2$  min SP) (19.2%) in paired Student's t-test. RPE in the first 30 minutes during both of the sessions showed a significant difference after 10 minutes from start exercise. POMS questionnaire values did not show any significant differences under both conditions (SS, SP). We found significant differences in the cerebral and muscular tissues oxygenation levels in the first 30 minutes of the exercise during SS and SP tests. In particular, at cerebral level, tissue oxygenation index was significantly larger in SS than in SP from the 10th to 30th min of exercise. Conclusion The study showed that the SS effect, compared to placebo condition, could not be an improvement of fatigue during an endurance exercise until exhaustion despite of an increase in tissue muscular and cerebral oxygenation. These data supported the hypothesis of a major activity induced by nicotine as a central stimulator (Mundel and Jones, 2006). References Mundel T, Jones DA. (2006). Effect of transdermal nicotine administration on exercise endurance in men. *Exp Physiol*, 91, 705-713 Zandonai T, Baraldo M, Franceschi L, Zappamiglio T, Chiamulera C. (2013). Effects of smokeless tobacco (snus) administration on exercise endurance in men. SRNT Annual Meeting Boston MA (USA) p 165

### CHANGES IN SKIN-GAS ACETONE CONCENTRATIONS FOLLOWING A LOW INTENSITY CONSTANT-LOAD EXERCISE

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Introduction Ketone bodies (3-hydroxybutyrate, acetoacetate and acetone) are generated in the liver, mainly from the oxidation of fatty acids, and are exported to peripheral tissues, such as the brain, heart, kidney and skeletal muscle for use as energy fuels (Mitchell et al. 1995). Acetone is mainly generated from decarboxylation of acetoacetate. Therefore, during exercise increased acetone levels related to exercise intensity have previously reported in plasma (Balasse et al. 1989), expired air, and skin-gas (Yamai et al. 2009). On the other hand, Romijn et al. (1993) have reported that peripheral lipolysis was stimulated maximally at 25 % VO<sub>2</sub>max during constant-load exercise. The purpose of the present study was to confirm changes in skin-gas acetone concentrations following a low intensity constant-load exercise. Methods Nine healthy male students performed constant-load (20% HRmax) cycle exercise for 30 min. The skin-gas samples were obtained by the covering left hand for 30 sec with a polyfluorovinyl bag (Tedlar bag; GLScience, Tokyo, Japan) in which pure nitrogen gas was introduced, and collected in a sampling bag at rest, 3, 6, 9, 12, 15, 20, 30 min after, and 5, 10, 20 min recovery of the exercise. Acetone concentration was analyzed by gas chromatography Results The skin-gas acetone concentration significantly increased 9-30 min after the exercise compared to the resting values ( $p < 0.05$ ), then immediately returned to resting values 5 min recovery of the exercise. Thus the peak skin-gas acetone concentration in the subjects was significantly ( $p < 0.05$ ) higher than the resting values ( $0.07 \pm 0.02$  vs  $0.17 \pm 0.07$  ppm; mean  $\pm$  SD). Discussion Increasing skin-gas acetone concentrations after the exercise in this study indicated that low intensity constant-load cycle exercise induced the production of ketone bodies in the liver, mainly from the oxidation of fatty acids (Mitchell et al. 1995), and some of increased ketone bodies eliminated as skin-gas acetone (Yamai et al. 2009). Furthermore, the levels of skin-gas acetone concentration seemed steady state 9-30 min after the exercise. These results indicated following possibilities. First, the production of ketone bodies in the liver might be reached maximal (Romijn et al. 1993) during this constant-load study. Second, the production of ketone bodies in the liver and consumption of ketone bodies in peripheral tissues such as skeletal muscles 9-30 min after the exercise might be same. References Mitchell GA et al. (1995) *Clin Invest Med* 18: 193-216. Balasse EO and Féry F. (1989) *Diabetes Metab Rev* 5: 247-270. Yamai et al. (2009) *Redox Report* 14: 1-5. Romijn et al. (1993) *Am J Physiol* 265: E380-E391. Contact Hiroshi Itoh (itoh.hiroshi@nitech.ac.jp)

### THE DEVELOPMENT OF FATIGUE MODEL IN A TISSUE-ENGINEERED MUSCLE

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Introduction Muscle fatigue is one of the typical physiological phenomena in physical exercise. Muscle fatigue can be classified as central fatigue or peripheral fatigue. Although peripheral fatigue is thought to be important contributor to muscle fatigue, the research have been limited because there are few useful model. Three-dimensional tissue-engineered muscle (3D TEM) is a powerful tool in studying muscle biology and physiology. However, it is not clear if 3D TEM can be a useful model in studying peripheral fatigue. Therefore, the aim of this study was to develop and evaluate fatigue model in 3D TEM. Methods 3D TEM having two artificial tendons were constructed from C2C12 myoblasts embedded in type-I collagen gel. 3D TEM in 3 weeks culture was used for fatigue experiment. The contraction of 3D TEM was induced by electrical stimulation. Isometric twitch force of 3D TEM was induced and measured in every 10 min by electrical stimulation. The isometric twitch contractility was evaluated after electrical stimulation. The LDH cytotoxicity assay was done to investigate muscle cell damage by electrical stimulation. Twitch force was re-measured at 24h after fatigue-induction to assess force recovery. Results The twitch tension of 3D TEM rapidly declined to nearly 10% to maximal twitch tension by 60 min with electrical stimulation. Relaxation time of 3D TEM did not significantly alter by the tension decline. There was no significant differences in LDH release between 3D TEMs stimulated and non-stimulated by electrical pulse. Twitch tension of 3D TEM could not recover from tension decline for 24h. Discussion One definition of fatigue is any decline in muscle performance associated with muscle activity (Allen et al., 2008). In this study, twitch tension in 3D TEM rapidly declined for 60 min with electrical stimulation. The decline of muscle strength with fatigue in vivo gradually recover to normal level. however, the tension decline did not recover for 24h in 3D TEM. According to the LDH cytotoxicity assay, the decline did not accompany cell damage. In case of muscle fatigue in vivo, the muscle relaxation time becomes longer but no significant alternation was observed after tension decline in 3D TEM. Taken together, 3D TEM can be highly applicable to the study of defining physiological mechanisms in peripheral muscle fatigue but the mechanisms may reflect a part of complicated pathways in peripheral muscle fatigue in vivo. References Allen, D. G., Lamb, G. D., Westerblad, H. Skeletal muscle fatigue: cellular mechanisms. (2008) *Physiol Rev*, 88, 287-332. Contact Tomohiro Nakamura tomohiro.nakamura@oit.ac.jp

## INFLUENCE OF VO<sub>2</sub> FLUCTUATIONS ON AMPK, p38-MAPK AND CAMKII SIGNALLING IN HUMAN SKELETAL MUSCLE

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**INFLUENCE OF VO<sub>2</sub> FLUCTUATIONS ON AMPK, p38-MAPK AND CaMKII SIGNALLING IN HUMAN SKELETAL MUSCLE** Introduction Skeletal muscle contraction increases intracellular ATP turnover, calcium flux and mechanical stress initiating signal transduction pathways that modulate transcriptional programs. The purpose of this study was to determine if the metabolic disturbances per se regulate signalling cascades known to regulate peroxisome proliferator-activated receptor  $\gamma$  coactivator-1 $\alpha$  (PGC-1 $\alpha$ ). Methods Nine males performed a continuous (30min) and an intermittent (30 times: 1min of exercise-1min of rest) exercises at 70% of VO<sub>2</sub>peak on two separate occasions. Skeletal muscle biopsies from the vastus lateralis were taken at rest and at +0h and +3h after exercise. Results VO<sub>2</sub> response analysis reveals a 3.3-fold higher metabolic fluctuations after intermittent exercise despite an identical energy expenditure (317  $\pm$  41 vs. 312  $\pm$  56 kJ after intermittent and continuous exercise, respectively). AMP-activated protein kinase (AMPK) (~2.9-fold,  $P < 0.01$ ), calcium/calmodulin-dependent protein kinase II (CaMKII) (~2.7,  $P < 0.01$ ) and p38 mitogen-activated protein kinase (MAPK) (~4.2,  $P < 0.01$ ) phosphorylation increased immediately after intermittent exercise to a greater extent compared to continuous exercise (condition-by-time interaction,  $P < 0.05$ ). Discussion The metabolic disturbances induced by intermittent exercise regulate the activation of multiple signaling pathways in response to a single bout of exercise. Further work is required to determine if the marked difference in signaling pathways activation during the present protocol would be manifest as divergent increases in mitochondrial content after a period of exercise training with the respective modalities. Contact adrien.combes@univ-lille2.fr

## THE RELATIONSHIP BETWEEN SELECTED ANTHROPOMETRIC MEASURES AND COMPETITIVE RANK IN PROFESSIONAL FEMALE SURFERS.

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Surfing is an intermittent exercise which in recent years has experienced a rapid increase in participation rates and growing professionalism amongst competitive athletes. Previous studies have investigated the relationship between anthropometric profiles and competitive ranking in various sports and within surfing in males. However no study has investigated these relationships in female surfers and no normative data exists for the anthropometric profile of professional female surfers competing under the current judging criteria. The aim of this study was to investigate the relationship between anthropometric measures and competitive ranking in female professional surfers. Following institutional ethical approval and the completion of informed consent professional female surfers (N = 27, age = mean 23.09, s = 4.58 years) participated in anthropometric measures of stature, body mass, skinfolds (Triceps, subscapular, biceps, iliac crest, supraspinal, abdominal, front thigh and medial calf), girths (arm flexed and tensed, waist, gluteal and calf) and breadths (humerus and femur). All measures were taken in accordance with the guidelines of the International Society for the Advancement of Kinanthropometry (ISAK). These were used to calculate body mass index, waist to hip ratio and body fat percentage. A Spearman's correlation analysis was performed using IBM SPSS Statistics 21 between the measured anthropometric variables and the numerical national ranking of the subjects. Significant ( $P < 0.05$ ) correlations with ranking were found for Sum of eight Skinfolds  $r = 0.42$  ( $R^2 = 0.26$ ) and Biceps skinfold  $r = 0.46$  ( $R^2 = 0.19$ ). Thus the coefficient's of determination for these suggest that 26% to 19% of the variance in ranking is explained by these measures within the sample used. No other significant correlations were found. These data provide some normative body composition data for this population of athletes and also suggest that higher levels of adiposity as measured through the sum of eight skinfolds and the biceps skinfold are associated with poorer rankings.

## ROLE OF ZINC IN THE EFFECT OF EXERCISE ON INTERMITTENT HYPOXIA-INDUCED LEFT VENTRICULAR DYSFUNCTION

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**Background:** Obstructive sleep apnea (OSA) is the recurrent obstruction of the upper airway leading to intermittent hypoxia (IH) during sleep. Although exercise can provide beneficial effects against myocardial injury induced by IH, its mechanism remains unclear. **Purpose:** To investigate the role of zinc in the effect of exercise on the left ventricular dysfunction in patients with OSA using an animal model mimicking IH of OSA. **Methods:** Nine-week-old male Sprague-Dawley rats were randomly assigned to four groups: control (CON, N = 15), intermittent hypoxia (IH, N = 15), exercise (EXE, N = 15) and IH combined with EXE (IH/EXE, N = 15). Each group was randomly assigned to receive intraperitoneal injections of the vehicle (n = 5), 10-mg/kg zinc chloride (ZnCl<sub>2</sub>, n = 5) or 5-mg/kg N,N,N',N'-tetrakis(2-pyridylmethyl)ethylenediamine (TPEN, n = 5). All injections were administered 30 min before IH exposure for 14 days. IH rats were raised without any intervention for first 8 weeks. At week 9 and 10, IH rats were exposed to 14 days of IH (2%-6% O<sub>2</sub>, 2-5 sec/75 sec) for 8 h/day. EXE rats were subjected to an animal treadmill for 10 weeks (5 day/week, 60 min/day, 24-30 m/min, 2%-10% grade) without IH exposure. IH/EXE rats were subjected to exercise training combined with IH exposure at week 9 and 10. At the end of 10 weeks, echocardiographic data were collected before rats were sacrificed. Then, their hearts were removed to determine the myocardial levels of inflammatory factors (tumour necrosis factor- $\alpha$ , interleukin-6 proteins and monocyte chemoattractant protein-1 and vascular cell adhesion molecule-1 mRNA), oxidative stress (2-thiobarbituric acid reactive substances and protein carbonyl), antioxidant capacity (catalase, superoxide dismutase, glutathione peroxidase and reduced glutathione activity), metallothionein and zinc. **Results:** Compared with those in CON rats, IH rats had a lower LV fractional shortening (LVFS %) and ejection fraction (LVEF %;  $p < 0.05$ ), which were reversed by ZnCl<sub>2</sub>. Furthermore, IH induced higher myocardial levels of inflammatory factors, oxidative stress and lower levels of antioxidant capacity ( $p < 0.05$ ), which were also reversed by ZnCl<sub>2</sub>. These changes were not observed in EXE and IH/EXE rats ( $p > 0.05$ ). Compared with the IH rats, IH/EXE rats had higher levels of cardiac function and antioxidant capacity as well as lower levels of inflammatory factors and oxidative stress ( $p < 0.05$ ); however, these results were reversed by TPEN intervention ( $p < 0.05$ ). **Conclusion:** Zinc exerts dual antioxidant and anti-inflammatory effects that play a critical role in exercise-induced cardioprotection against IH-induced left ventricular function impairment.

## CHANGES OF CARDIOVASCULAR STRESS DURING EACH 5 MIN AND 15 MIN OF COMPETITIVE FOOTBALL MATCH PLAY IN JUNIOR FOOTBALL PLAYERS

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**Introduction** Football is a noncontinuous team game where workload on players vary continuously - from standstill condition to short bursts of sprint or explosive jumps or kicks. Continuous recording of heart rate (HR) can be used to assess cardiovascular stress on football players during real match play. **Objectives** Major objectives of the present study were to determine whether the cardiovascular stress on footballers varies significantly for each 5 min and 15 min of play. **Methods** Five junior footballers (16.1±1.3 years), participating in Indian Junior National Football Championship, volunteered in this study. Two players were selected from one team and three from another. Of the 5 players volunteered, two each were midfielders and defenders and the rest was a forward. HR of the footballers were recorded in two league matches (preliminary round) of the tournament. VO<sub>2</sub>max and maximum HR (HR<sub>max</sub>) of the players were measured by graded exercise protocol on treadmill. HR was measured continuously at an interval of 5 s by heart rate telemeter (Sport Tester, PE3000). **Results** VO<sub>2</sub>max and HR<sub>max</sub> of the volunteers were recorded as 52.3±4.1 ml/kg/min and 200.4±2.3 beats/min respectively. Mean HR (HR<sub>mean</sub>) for each 5 min of play frequently differ significantly during the game in all the five players. HR<sub>mean</sub> for each 15 min of play, on the other hand, did not vary significantly in four of the volunteers, although it varied significantly only in one of the players. Analysis of the HRAT shows that players played about 48.5% of the time in the anaerobic zone and 51.5% of the total time in aerobic zone. **Discussion** The study concludes that: (1) although ball possession and attack index can vary tremendously (as supported by other studies) but cardiovascular stress of junior footballers for each 15 min of football match play differs only occasionally, (2) significant variation of cardiovascular stress for each 5 min of football match play occurs frequently, and (3) aerobic and anaerobic systems contribute almost equally in providing energy in junior footballers during competitive match play. **References** Reilly T, Thomas V (1976). *J. Human Movement Studies* 2, 87-97. Soars J M C (1988). *J Sports Med* 28, 220-223. Alexandre D, da Silva CD, Hill-Haas S, Wong del P, Natali AJ, De Lima JR, Bara Filho MG, Marins JJ, Garcia ES, Karim C. (2012). *J Strength Cond Res* 26, 2890-906. Contact subirgupta@yahoo.com

## THE EFFECTS OF VARIOUS CONCENTRATIONS OF CARBOHYDRATE MOUTH RINSE ON CYCLING TIME TRIAL PERFORMANCE IN A FED STATE.

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**Introduction:** Mouth rinsing with a 6% carbohydrate solution has been reported to enhance cycling and running time trial performances in endurance based events when in a fasted state (Carter et al 2004). The objective of the current study was to identify the effects mouth rinsing with a 6% and 16% carbohydrate solution (CHO) has on time trial performance when compared to a 0% control solution (PLA) when in a fed state. **Methods:** Twelve recreationally active males completed three time trials of a set workload (600 ± 65 W), rinsing a 25ml bolus of a 0% PLA, 6% or 16% CHO (Maltodextrin) every 12.5% of the time trial performance completed. Rating of perceived exertion (RPE), heart-rate and cadence were recorded every 12.5% completion with blood lactate levels recorded at every 25%. Results were analysed using a Two-Way Anova (SPSS 22.0) with p=0.05. **Results:** Performance times significantly improved when using the 6% CHO and 16% CHO versus the PLA trial (6%: 58.82 ± 7.03min v 62.31 ± 7.62min, p = 0.002; 16%: 57.9 ± 7.62min v 62.31 ± 7.62min, p<0.001) respectively. No significance variation was observed when comparing the 6% CHO to 16% CHO (p = 0.244). There was no significant difference between heart rate levels or RPE values across the three trials. **Discussion:** The results of the study indicate that CHO rinsing leads to improvements in performance times in cycling time trial performance while participants were in a fed state. The improvements observed in cycling performance can be associated with the higher levels of power output sustained in both CHO trials. The results support the previous findings by Carter and colleagues (2004). In conclusion mouth rinsing with a 6% or 16% CHO solution has a positive effect in a cycling time trial performance in recreational active males when performed in a fed state. **References:** Carter, J. M., Jeukendrup, A. E., & Jones, D. A. (2004). The effect of carbohydrate mouth rinse on 1-h cycle time trial performance. *Medicine and science in sports and exercise*, 36(12), 2107-2111. Contact: simon.devenney@gmail.com

## ELECTROMYOGRAPHY MUSCLE ACTIVITY IN UNILATERAL AND BILATERAL SQUATS WITH RELATIVE LOADS

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**Introduction** Unilateral strength training is becoming popular as a complement to bilateral training particularly in athletes active in sports performed primarily on one leg. Some studies have shown improved performance after unilateral compared to bilateral strength training, however the underlying cause for this improvement is unclear. The aim of this study was to compare electromyography (EMG) muscle activity in unilateral and bilateral squats performed with 80% of 1repetition maximum (RM) performed in a smith machine. **Methods** Participants in the study were 12 healthy women and men (mean age 25±2 years) with previous weight-lifting experience. EMG activity was measured during the concentric phase in the muscles vastus lateralis, biceps femoris, gluteus medius and erector spinae during A) a maximal voluntary isometric contraction (MVIC), B) 1RM squat (90 degree knee flexion) bilaterally and unilaterally, and C) 3 repetitions 80% of 1RM for both the unilateral and bilateral stance, where each squat was performed at a set speed with the aid of a metronome. **Results** EMG activities, calculated as percent of MVIC, in thigh and hip muscles (vastus lateralis, biceps femoris, gluteus medius) were significantly higher (p<0.01 for all) in the unilateral compared to the bilateral stance. The highest increase in EMG activity was in the gluteus medius where the unilateral squat elicited a 2.9 increase compared to bilateral stance. Unilateral stance muscle activation was in vastus lateralis 1.2 times higher and in biceps femoris 1.5 times higher compared to the bilateral stance. For the trunk muscle erector spinae, the opposite was apparent. EMG activity was 0.6 times lower (p<0.01) when the squat was performed unilaterally compared to bilaterally. **Discussion** Even when the load is made relative to the 1RM for each stance the muscles in especially the gluteus medius but also vastus lateralis and biceps femoris is activated to a higher degree when performed unilaterally which could be a partial explanation as to why the unilateral stance can be beneficial to include in a strength training regime despite the absolute load being lower. Contact charlotte.olsson@hh.se

## ARE SKYDIVING RESULTS DETERMINED BY VO<sub>2</sub>MAX AND AEROBIC PERFORMANCE?

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**Introduction.** We all know that skydiving is a sport for people with no fear, or at least that's the general opinion but question could be asked: Is skydiving in correlation with fitness level of the jumpers? After 2014 Skydiving championship held in Bosnia, Banja Luka, 10 skydivers were chosen to take part in this study. Five were ranked between top 10 and five ranked between last 20. All subjects were sedentary men, age  $27 \pm 3$ , and weight  $86 \pm 8$ kg, height  $174 \pm 8$ cm. First five had 600+ number of jumps thus second five had no more than 250 jumps. The aim of this study was to examine the fitness level and VO<sub>2</sub>max of skydivers and to see if there is a correlation with their competition results. **Methods.** Research was conducted on Institute for Sport and Occupational Medicine in Banja Luka, on COSMED (Italy) Quark PFT Ergo with real breath by breath gas exchange data analysis (VO<sub>2</sub>, VCO<sub>2</sub>) indirect calorimetry and RS232 ergometer control. Primary parameter that was measured was VO<sub>2</sub>max ml/kg/min and body composition. **Results.** Jumpers from the top five group had a value of 53 ml/kg/min VO<sub>2</sub>max with standard deviation of  $\pm 4$  ml/kg/min. Jumpers from the last five group had a value of 51 ml/kg/min with deviation of  $\pm 3$  ml/kg/min. **Conclusion & Discussion.** As we can see no significant difference between two groups was found. Primary difference was the history of the jumps. If we know that skydiving is associated with increase in anxiety, stress and cortisol levels which lead to increase in blood flow, heart rate rise and blood pressure rise we can conclude that that skydivers suffer from acute cortisol activation and therefore understand their high VO<sub>2</sub>max values although they practice no other activity besides skydiving. No statistical significance was found between skydiving result and VO<sub>2</sub>max either that they possess higher values than average population. We can conclude that number of jumps and experience are the determining factor in competition results. **References.** State anxiety and cortisol reactivity to skydiving in novice versus experienced skydivers, Olivia A. Hare, Mark A. Wetherell, Michael A. Smith, *Physiology & Behavior*, Volume 118, pp 40–44, 2013. Motivation, Stress and cortisol responses in skydiving, JOANNE THATCHER, SUE REEVES, DEBBIE DORLING, and ANNA PALMER, *Perceptual and Motor Skills: Volume 97, Issue , pp. 995-1002, 2003.*

## INFLUENCE OF ARM CRANK EXERCISE LACTATE INDUCTION ON SUBSEQUENT NUMBER OF REPETITIONS IN LEG PRESS EXERCISE

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**Introduction:** Warm-up is a standard procedure before high intensity exercise but the effects on performance are not well understood (1). Too intense warm up inducing high lactate concentrations is suggested to reduce subsequent performance (2). Applying the lactate shuttle theory high systemic lactate levels inhibit glycolysis and favour aerobic metabolism which should positively influence strength endurance performance (3). The aim of this study was to analyse the influence of a lactate induction by high intensity arm crank exercise on a subsequent two set strength endurance leg press exercise. **Method:** 6 male students ( $25.8 \pm 5.2$  years,  $73.5 \pm 8.3$  weight) performed a 1 RM test to obtain maximal leg press performance. Several days later subjects performed leg press strength endurance exercise at 60% 1RM either with or without hand crank exercise pre-load in a randomized order with at least 1 week between tests. Subjects heart rate (HR) was measured continuously as well as blood lactate concentration (La) before and after a general warm up, the pre start phase with and without a 30s all-out hand crank exercise at 400 W, before and after each of the 2 sets of leg press exercise. Gas exchange data as well as heart rate (HR) were obtained continuously for all tests. **Results:** Number of repetitions was significantly higher after prior arm crank exercise ( $30.7 \pm 5.1$ ,  $29 \pm 6.2$ ) compared to the non-pre-load intervention ( $25.8 \pm 4.1$ ,  $24.2 \pm 3.9$ ) for the first and second set respectively. Net lactate ( $43.6\%$ ), respiratory exchange ratio (RER) ( $1.4 \pm 0.2$  vs.  $1.2 \pm 0.2$ ) and carbon dioxide (VCO<sub>2</sub>) ( $1.033 \pm 0.427$  vs.  $1.017 \pm 0.376$  l.min<sup>-1</sup>) were significantly decreased ( $P < 0.05$ ) using high intensity arm crank exercise pre-load. HR ( $109 \pm 17$  vs.  $135 \pm 11$  min<sup>-1</sup>) but not oxygen uptake ( $0.727 \pm 0.331$  vs.  $0.807 \pm 0.281$  l.min<sup>-1</sup>) was significantly increased ( $P < 0.05$ ) after pre-load. **Conclusion:** As expected from the theoretical assumption, number of repetitions increased significantly and net La increase was clearly diminished due to the La induction by hand crank exercise. Gas exchange data validated the shift to aerobic metabolism with a decreased RER and a lower CO<sub>2</sub> output. These results indicate that knowledge and application of the lactate shuttle theory may give unexpected effects on exercise performance. **References:** 1) Beckenkamp PR, Lin CC.: *Br J Sports Med.* 2011 May;45(6):525-6. 2) Christensen PM, Bangsbo J.: *Int J Sports Physiol Perform.* 2014 Sep 17. 3) Müller A., et al. in: Müller, E., Kröll, J., Lindinger, S., Fusterschmied, J., Stöggl, T. (eds.): *Science and Skiing VI.* Meyer & Meyer Sport (UK) 2014: 224-230. Contact: peter.hofmann@uni-graz.at

## A COMPARATIVE STUDY BETWEEN HIGH INTENSITY EFFORTS PLAYERS OF 1ST AND 2ND DIVISION OF A SPANISH PROFESSIONAL SOCCER TEAM

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**Introduction** The ability to repeated sprint ability (RSA) is a prerequisite for performance in soccer (Stolen, 2005), regardless of the technical and tactical skills (Buchheit, 2013). The efforts of maximum intensity above 18-19km/h (Bishop, 2011;Wragg, 2000), however when the recovery periods between sprint are prolonged (>60s) the ability to repeat sprint does not decrease or minimally reduced, whereas when the recovery periods are short (<60s) the yield decreases (Bishop, 2004;Girard, 2011). Some authors have found a higher RSA regarding professional footballers (Impellizzeri, 2008) for both individual RSA could determine that a player from competing in a particular sport level (1st or 2nd division). The aim of this study is to evaluate and compare the duration of the efforts of RSA and recovery times between these players during a match. **Methods** Five players of each category were selected randomly (one per seat). They were placed a GPS during halftime of a training match (45m), the number of efforts of more than 18km/h, the duration thereof and the time elapsed between them was measured and compared the results between the players of 1st and 2nd division. The difference between number of sprints, sprints and recovery time among heart rate and measured with global positioning system was analysed using T-test for two related samples. **Results** The numbers of sprints registered were 32 to first division players and 31 to second division players. The most important results were the recovery time between sprints. The first division players showed minor recovery time between efforts with significant different (first division players:  $1.2 \pm 0.37$  min vs. second division players:  $2.92 \pm 0.58$  min;  $p = 0.04$ ). **Conclusions** Differences in the recovery periods between high intensity efforts among players of 1st and 2nd division, may be a factor to consider in the yields of the players in both categories. **References** Bishop, D., Edge, J., Davis, C., & Goodman, C. (2004). *Med Sci Sports Exerc*, 36(5), 807-813. Bishop, D., Girard, O., & Mendez-Villanueva, A. (2011). *Sports Med*, 41(9), 741-756. Buchheit, M., Simpson, B. M., & Mendez-Villanueva, A. (2013). *Int J Sports*

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### MOVEMENT PATTERNS AND METABOLIC RESPONSES DURING AN INTERNATIONAL TOURNAMENT OF RUGBY SEVENS

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This study investigated the physical and physiological demands during an European rugby Sevens tournament. In this tournament, twelve elite players of rugby Sevens participated to 7 matches, analysed for each player with Global Positioning System, in order to determine mean movement patterns and to subcategorise players' performance into whole matches (WM) and substitutes (S). Distance covered were categorised with individual maximal sprinting speed (MSS) and maximal aerobic speed (MAS). Blood samples were taken to assess changes in acid-base balance at rest and after each match. During the tournament, mean time of play was  $66 \pm 14$  min ranging from 40 to 86 min; mean total distance covered was  $5846 \pm 1209$  m ranging from 3605 to 8051 m. For all players ( $\pm$  SD): mean relative total distance covered was  $91 \pm 13$  m.min<sup>-1</sup> ranging from 65 to 122 m.min<sup>-1</sup>; Although S players covered significantly more relative distance above MAS than WM players ( $18.8 \pm 8.2$  vs  $14.5 \pm 4.8$  m.min<sup>-1</sup>;  $p < 0.05$ ), there was no significant effect of player's status, time or total distance covered on the significant variation of blood pH, bicarbonate concentration ([HCO<sub>3</sub><sup>-</sup>]) and lactate concentration ([La]) post-match. For all players blood pH and [HCO<sub>3</sub><sup>-</sup>] significantly decreased post-match compared to pre-match (7.41 to 7.26 for pH; 24.5 to 13.8 mmol.L<sup>-1</sup> for [HCO<sub>3</sub><sup>-</sup>];  $p < 0.01$ ). Blood [La] significantly increased post-match compared to pre-match (2.5 to 11.7 mmol.L<sup>-1</sup>;  $p < 0.01$ ). Relative distance covered above MAS was inversely correlated to pH and [HCO<sub>3</sub><sup>-</sup>] ( $r = 0.44$  and  $r = 0.42$  respectively;  $p < 0.01$ ), and correlated to [La] ( $r = 0.36$ ;  $p < 0.05$ ). Relative distance and relative distance covered above 30% of anaerobic speed reserve during the one minute peak activity was correlated to [La] ( $r = 0.39$  and  $r = 0.39$  respectively;  $p < 0.01$ ). For the first time on rugby Sevens, physical demands with individualized velocity thresholds, was observed during European tournament. Moderate relationships were found between match activity and blood metabolic parameters (pH, [HCO<sub>3</sub><sup>-</sup>] and [La]), observed post match, suggesting that post match recovery should be tailored regarding match activity. Also, the peak values observed in this study ([La] up to 19.3 mmol.L<sup>-1</sup>; pH close to 7.05) are questioning about fatigue in rugby Sevens.

### EFFECTS OF COMBINED EXERCISE ON BDNF, FGF, TOTAL-GHRELIN AND ACYLATED-GHRELIN IN OBESE ADOLESCENTS

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Exercise has been reported to improve cognitive function in humans and rodents, possibly via BDNF (brain-derived neurotrophic factor) and FGF (Fibroblast growth factor) and regulated mechanism. BDNF and obesity-related factors have been reported to be associated. The purpose of this study was to investigate the effects of combined exercise on body composition, blood lipids, BDNF, FGF and ghrelin in obese adolescents. The subjects of this study were 20 boys, who were divided into combined exercise group (EG, n=10), control group (CG, n=10). The combined exercise program conducted 50-60 minutes per day, four times a week, for 12-week. The results of comparative analysis are as follows. The comparison of means difference before and after intervention between group, weight ( $p < 0.05$ ), BMI ( $p < 0.05$ ), Acylated-ghrelin ( $p < 0.05$ ) of EG were more significant decreased than CG. And BDNF ( $p < 0.05$ ), Total-ghrelin were more significant increased than CG. Fat mass, Fat percentage, Muscle mass, Muscle percentage, TC, TG, Glucose, HDL-C and FGF were not different between EG and CG. But in exercise group, Weight, BMI were significant decreased and Muscle percentage was significant increased after 12 weeks. These results indicate that 12 weeks combined exercise decreased Weight, BMI, Acylated-ghrelin and increased concentrations of BDNF, Total-ghrelin in the serum, suggesting a possible functional role for growth of nerve cells and improves energy metabolism and appetite in exercise-induced weight loss in humans.

### RELATIONSHIP AND INTERRELATED FACTORS BETWEEN PHYSICAL PERFORMANCE AND BIOCHEMISTRY PARAMETERS IN COMMUNITY-DWELLING OLDER MEN

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Introduction: Aging is associated with several morphofunctional changes, which in association with sedentarism reduce the functional capacity and impair the physical performance of older adults. Age related change in biochemistry parameters are of great importance in evaluating the aging conditions. The study aimed to investigate the relationship between biochemistry parameters and physical performance in older men lived in rural community in Taiwan. Method: 1033 men over 65 years old lived in Tianliao District, Southern Taiwan was selected in an epidemiological survey. A total of 414 subjects were enrolled, the respond rate was 60.8%. Not only structured questionnaires were inquired, but also physical activity of weekly, hip bone mineral density and serum biochemistry parameters such as vitamin D, creatinine, GFR-CG (Glomerular Filtration Rate -Cockcroft-Gault), GFR-MDRDs (Glomerular Filtration Rate -Modification of Diet in Renal Disease) and HDLC (High-Density Lipoprotein Cholesterol) were collected. The physical performance tests included grasp test of dominant hand (grip-D, TKK 5401, Japan), muscle strength/endurance (30-s chair stand test), balance (open-eye stand on right foot), flexibility (chair sit-and-reach test), and reaction (8-feet walking test). Results: There were 402 subjects completed the study, the average age was  $74.5 \pm 6.0$  (range=65-98) y/o. Using multiple linear regression models, the independent factors ( $\beta$  coefficient) for different physical performance tests were listed as follows: 30-s chair stand test: age (-0.295), percent body fat (-0.136), socioeconomic state (0.101), smoking (-0.219), physical activity (0.178), creatinine with 1.5ng/ml cut point (-0.099) and GFR-MDRDs with 60 ml/min/1.73 m<sup>2</sup> cut point (0.106); open-eye stand: age (-0.386), BMI (-0.17) and fasting blood glucose (-0.175); chair sit-and-reach test: age (-0.169); 8-feet walking test: age (0.322), BMI (0.156), tea drinking habit (-0.122), physical activity (-0.22) and glucose (0.1); hand grip test: age (-0.386), BMI (0.207), physical activity (0.144), and albumin (0.135). Conclusion: There was no significant association between Vitamin D, HDLC and physical performance. We can use creatinine and GFR-MDRDs to predict the muscle strength and endurance of elderly, and fasting blood glucose may use to predict balance and reaction ability of elderly. These results will provide the general status of physical functions and the value of indicators to show interrelated with biochemistry data. 1. Joane Mattaa, Nancy Mayo et al. (2014) Experimental Gerontology, 55, 37-43 2. Hardy R, Cooper R et al. (2013) PLoS ONE 8(2) e56483. 3. Denise K. Houston, Janet A. Tooze, et al. (2012) Am. J. Epidemiol., 176 (11), 1025-

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### EFFECT OF DEVELOPMENT OF GLUCOSE INTOLERANCE ON DIAPHRAGM MUSCLE FUNCTION IN TYPE 2 DIABETIC RATS

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**Introduction** Patients with type 2 diabetes may have some respiratory muscle weakness (Correa et al., 2011). However, how respiratory muscle weakness is developed in type 2 diabetes is still unclear. The aim of this study was to investigate the effect of development of type 2 diabetes on diaphragm muscle function. **Methods** Sixteen Otsuka Long-Evans Tokushima Fatty (OLETF) rats, a model of type 2 diabetes mellitus, and 12 non-diabetic control Long-Evans Tokushima Otsuka (LETO) rats were used. Rats were housed in a climate-controlled room and given standard rat chow and water ad libitum from 5 to 25 weeks of age. A strip of diaphragm was used to measure the force production (N/cm<sup>2</sup>) at 1, 15, 30, 60 and 100Hz of stimulation frequencies at 5 and 25 weeks of age and the rest was frozen and stored for histochemical analysis. Results Body weight in OLETF rat was greater than that of LETO rat in both 5 and 25 weeks of age (P<0.01). Blood glucose area under the curve in OLETF rat was greater than that of LETO rat at 25 weeks of age (P<0.01) while no difference was observed at 5 weeks of age. Muscle fiber cross sectional area was larger in OLETF rat than LETO rat in both ages (P<0.05). Diaphragm force production in OLETF rat was lower than LETO rat in both ages (P<0.01). Neutral lipids in muscle fiber was greater in OLETF rat than LETO rat at 5 weeks of age (P<0.01), whereas the difference was disappeared at 25 weeks of age. There was a negative correlation between neutral lipids and force production at 5 weeks of age (30, 60, and 100Hz, p<0.01), however, no correlation was observed at 25 weeks of age. **Discussion** OLETF rats showed type 2 diabetes at 25 weeks of age as same as a previous study (Kawano et al., 1992). In OLETF rat, diaphragm force production was already lower and neutral lipids in muscle fiber was greater at 5 weeks of age, even without glucose intolerance. There was a possibility that high neutral lipid levels might affect lower force production per unit in OLETF rat at 5 weeks of age under tetanized state. Similarly, force production was lower in OLETF rat after onset of diabetes, however neutral lipid did not relate the force production. **References** Correa, A. P., Ribeiro, J. P., Balzan, F. M., Mundstock, L., Ferlin, E. L. & Moraes, R. S. (2011). Med Sci Sports Exerc, 43, 1135-41. Kawano, K., Hirashima, T., Mori, S., Saitoh, Y., Kurosumi, M. & Natori, T. (1992). Diabetes, 41, 1422-8. Contact noriko.sekine@ouj.ac.jp

### THE EFFECT OF VOLUNTARY EXERCISE ON THE COMPOSITION OF GUT MICROBIOTA IN MICE.

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**Introduction** Recently, it is well-known that the composition of gut microbiota is related to health and illness. Exercise also has health benefits, but that the effect of exercise on the composition of gut microbiota is unclear. Therefore, the aim of this study was to examine the composition of gut microbiota by voluntary exercise in mice. **Methods** Male Balb/c (8 weeks) mice were divided into 2 groups: sedentary and exercise. Mice were individually housed under sedentary condition (SED, n=9) or given free access to a running-wheel (Ex, n=8) for 16 weeks. Fecal samples were collected after 16 weeks for bacterial DNA isolation. We analyzed the samples by using Terminal Restriction Fragment Length Polymorphism (T-RFLP). **Results** The body weight of mice in Ex did not change compared with Sed throughout the experiment. The volume of physical activity in Ex did not show significant change for 16 weeks (average  $1.5 \times 10^5$  counts/week). Ex significantly elevated the proportion of Lactobacillales order compared with Sed, whereas were significantly reduced the proportion of Bacteroides genus. **Discussion** Voluntary exercise for 16 weeks changed the composition of gut microbiota in mice. Ex elevated the proportion of Lactobacillales order. Our result agrees with previous studies in rats (Queipo-Ortuño et al., 2013; Petriz et al., 2014). Most of Lactobacillales order is able to produce the organic acid (ex, lactate or butyrate), which cause lower the pH in intestinal tract due to inhibit the proliferation of destructive fungus. In addition, butyrate has an inhibitory effect of colon cancer (Blouin et al., 2010). Meanwhile, Bacteroides genus reduced in Ex. Generally, it is well known that Bacteroides genus is one of pathogenic bacteria in opportunistic infections. The diversity of gut microbiota reduced in EX. In conclusion, exercise alters the composition of gut microbiota in mice, especially the proportion of Lactobacillales order increase. **References** Queipo-Ortuño MI, Seoane LM, Murri M, Pardo M, Gomez-Zumaquero JM, Cardona F, Casanueva F, Tinahones FJ. (2013). PLOS ONE, 8, e65465 Petriz BA, Castro AP, Almeida JA, Gomes CP, Fernandes GR, Fernandes KR, Kruger RH, Pereira RW, Franco OL. (2014). BMC Genomics. 21, 511. Blouin JM, Penot G, Collinet M, Nacfer M, Forest C, Laurent-Puig P, Coumou X, Barouki R, Benelli C, Bortoli S. (2010) Int J Cancer, 128, 2591 Contact Yuko Tanimura (tanimura.yuko@aichi-toho.ac.jp)

### CAN THE 'REPEATED BOUT EFFECT' AFTER ECCENTRIC EXERCISE BE REMOVED?

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**INTRODUCTION** An "absolute norm" in eccentric exercise is the "repeated bout effect", which describes a gradual attenuation of muscle damage after repeated eccentric exercise sessions. Although the repeated bout effect is considered as a protection mechanism that allows repeated eccentric exercise without or reduced damage, it is also a barrier for investigating the role of chronic exercise-induced muscle damage in adaptations. Based on evidence that concentric-only exercise renders the muscle more vulnerable to damage after a subsequent eccentric exercise session, we designed a protocol with alternating cycles of concentric-only exercise that exposes the muscles to increased damage during the subsequent eccentric-only exercise. This was an attempt to attenuate and/or remove the repeated bout effect by exploiting muscle mechanic specific adaptations during concentric-only and eccentric only exercise. **METHODS** Seventeen males were assigned into i) the alternating eccentric-concentric exercise group switching between eccentric-only and concentric-only exercise every 4 weeks and ii) the eccentric-only exercise group performing only eccentric muscle actions. The two groups performed 8 weeks of exercise using the knee extensors on an isokinetic dynamometer. Indices of muscle damage (isometric torque, muscle soreness, range of motion and creatine kinase) and inflammation (C-reactive protein) were measured. **RESULTS** Both groups at the first 4 weeks of eccentric exercise exhibited a typical manifestation of the repeated bout effect, namely a marked reduction of muscle damage. However, in the alternating group, the subsequent 4 weeks of concentric-only exercise were sufficient to bring muscle nearly back to its unaccustomed state. In particular, the last eccentric exercise session, which was preceded by a month of concentric-only exercise, induced muscle damage similar to that experienced after the first eccentric exercise session. In the eccentric-only exercise group, the last eccentric exercise session did not cause any alterations in muscle damage and inflammation. **DISCUSSION** Concentric exercise results in

removal of sarcomeres in series previously added by eccentric exercise and that any subsequent eccentric action overstretches the fewer sarcomeres leading to damage. On this basis, we invented an alternating eccentric-concentric exercise scheme, which has successfully overcome the repeated bout effect leading to repeated episodes of muscle damage. This novel exercise scheme will allow investigating the potential role of exercise-induced muscle damage as a stimulus for various potentially beneficial exercise adaptations. CONTACT nikolaidis@auth.gr

### ANALYSIS OF INTERNAL AND EXTERNAL LOADS IN VOLLEYBALL PLAYERS DURING OFFICIAL MATCHES

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**Introduction** During a sports competition, it is known that athletes are under pressure for many causes, generating a psychophysiological stress that can directly influence performance. The purpose of this study was to identify and to correlate competitive external load (EL) with internal load (IL) magnitude and with symptoms of stress (SS) during an official competition. **Methods** Eleven volleyball players competing in triangular qualifying competitive matches participated in this study. Specific volleyball motor actions (MA) were filmed to determine EL while PRE session (Foster, 1998) and salivary cortisol (sC) collected after matches were used to analyze IL. DALDA questionnaire (Rushall, 1990) was used to determine SS, being the answers 'worse than normal' from part 'B' of the questionnaire retained for analysis. **Results** Analysis of variance showed effect on sC concentration in 4 moments of analysis, with a significant difference from baseline for matches 1, 2 and 3 ( $p < 0.01$ ); SS values differed from pre moment for matches 2 and 3, and from match 1 to 2 and 3 ( $p < 0.05$ ). MA differed significantly from match 2 to matches 1 and 3 ( $p < 0.01$ ), as well as from session RPE to match 2 to matches 1 and 3 ( $p < 0.05$ ). There was a positive association between MA and quantification of session RPE in 3 matches and significant in match 2,  $r = 0.69$ . **Discussion** Unlike the initial hypothesis, salivary cortisol levels were not influenced by different workloads during the three matches, demonstrating that main stress hormone may be being modulated by psychological factors involved in an official match, corroborating with some authors who indicate that in training matches there is not significant increase in cortisol in athletes very well adapted for the demand for training and competitions (Moreira, et al, 2009; Elloumi, et al, 2003). **In conclusion**, it was demonstrated that stress generated by competitive matches increases salivary cortisol concentrations post match, but this increment is not directly associated with increase of volleyball motor actions. In addition, with the association between volleyball motor actions and session RPE, we conclude that this psychometric instrument is sensitive to determine external load caused by official volleyball matches. **References** Foster C. Med Sci Sports Exerc. 1998 Jul;30(7):1164-8. Rushall BS. 1990; 2(15). Moreira A, Arsati F, de Oliveira Lima Arsati YB, da Silva DA, de Araujo VC. Eur J Appl Physiol. 2009 106(1):25-30. Elloumi M, Maso F, Michaux O, Robert A, Lac G. Eur J Appl Physiol. 2003 90(1-2):23-8. amortatti@ufrnet.br

### THE EFFECTS OF UPPER BODY SPRINT INTERVALS ON UPPER BODY STRENGTH AND AEROBIC CAPACITY IN FEMALE CROSS-COUNTRY SKIERS

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**Introduction** Cross-country skiing is regarded as a demanding endurance sport. In classical skiing, the increased race speeds, caused by new competition forms and better prepared race tracks, have led to more use of the double poling technique and, subsequently, greater importance of upper body strength and endurance capacity. The purpose of this study was to compare the effects of 30-s sprint intervals with continuous training of the upper body in improving upper body maximal strength as well as upper- and whole body aerobic capacity among highly trained female cross-country skiers. **Methods** 17 highly trained junior female cross-country skiers (age=18.1±0.8yrs,  $VO_{2max}=3.30\pm0.37$  L/min) performed an 8-week intervention training period where a sprint interval training group (SIT; n=8) added 2 weekly sessions of 6-8x30-s maximal upper-body intervals while poling either using a roller board in a kneeling position or by double poling on roller skis. The control group (CON; n=9) added a weekly session of continuous double poling on roller skis at 70- 80% of their maximal heart rate. Upper body 1RM in a poling specific strength exercise and peak oxygen uptake in isolated upper body poling using a Concept2 Ski-ergometer (Skierg- $VO_{2peak}$ ), as well as in double poling (DP- $VO_{2peak}$ ) and diagonal stride (DIA- $VO_{2peak}$ ) roller skiing was tested pre and post to the intervention. **Results** The groups did not significantly differ at the pre-tests and only the experimental training differed during the intervention training period. Both groups improved all tests from pre- to post-test conditions. SIT improved 1RM more than CON (17.6% vs 9.8%,  $p < 0.001$ ). The improvements in DP- $VO_{2peak}$  (10.8% vs 6.4% for SIT and CON) or Skierg- $VO_{2peak}$  (12.5% vs 9.3% for SIT and CON) did not significantly differ between groups, whereas the increase in DIA- $VO_{2peak}$  improved significantly more for SIT than for CON (8.6% SIT vs CON=2.6%,  $p = 0.003$ ). **Discussion** While both SIT and CON significantly improved all tests by adding upper body session upon their normal training regimes, SIT increased maximal strength and whole body aerobic capacity more than CON. These findings indicate a large potential for female junior skiers to improve their physiological capacities by increased focus on upper body training in general, and that SIT tends to be particularly effective for improving both strength and aerobic capacity over an 8 week period.

### EFFECTS OF ACUTE HYPOXIA AND HYPEROXIA ON ENERGY AND GLUCOSE METABOLISMS DURING INCREMENTAL EXERCISE

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**Introduction** Peak oxygen uptake and/or exercise performance will be reduced during hypoxia and higher during hyperoxia compared with normoxia. Also, energy metabolism mechanisms during exercise under hypoxia have been proposed. That is, previous studies suggested that hypoxia stimulate energy expenditure and glucose metabolisms. However, the mechanisms underlying the energy and glucose metabolisms effect of hyperoxia were not fully understood. **Purpose** Our study focuses on the effect of acute hypoxia and hyperoxia on energy expenditure and glucose oxidation during exercise. **Methods** Nine healthy male subject performed incremental maximal exercise test (15W/min step) under normoxia (Norm: 20.9 FIO<sub>2</sub>), acute hypoxia (Hypox: 14.5% FIO<sub>2</sub>) and acute hyperoxia (Hyper: 28.0% FIO<sub>2</sub>) conditions. The order of each condition was randomized and trials were spaced by 3 days. We measured oxygen uptake on incremental exercise. Energy expenditure rate (EER) and glucose oxidation rate (GOR) were calculated by the formula of Bursztein et al. Continuous data of EER and GOR were collapsed to analyze specific time points of interest, corresponding to 25, 50, 75, and 100% of  $VO_{2peak}$  under three conditions. Repeated-measures ANOVA were performed across treatments. **Results** As expected,  $VO_{2peak}$  decreased in Hypox (38.8±4.6ml/kg/min) and also increased in Hyper (48.4±5.1ml/kg/min) compared with Norm (45.7±5.6ml/kg/min,  $P <$

0.05). EER was progressively increased during exercise at three conditions, but there is no difference among Norm, Hypox and Hyper condition. During Hypox, GOR (from  $0.308 \pm 0.062$  to  $2.276 \pm 0.131$  mg/min/m<sup>2</sup>) as work rate from 20 to 80% VO<sub>2</sub>peak were higher than that of Norm (from  $0.184 \pm 0.081$  to  $1.946 \pm 0.367$  mg/min/m<sup>2</sup>,  $P < 0.05$ ). Conclusion Acute hypoxia would be enhanced GOR during exercise, although there was no difference in EER in comparison with normoxia and/or hyperoxia. Also, It is unlikely that changes in EER and GOR related with increased oxygen uptake in hyperoxia. References Katayama, K., K. Goto., K. Ishida., and F. Ogita. (2010) *Metabolism*. 59: 959-966. Roberts, A.C., J.T. Reeves., G. E. Butterfield., R.S.Maxeo., J.R. Sutton., E.E.Wolfel. and G.A. Brooks. (1985) *J. Appl. Physiol.* 80: 605-615 Contact : jn-uchimaru@sendai-u.ac.jp

## EXAMINATION OF THE EFFECT OF TRUNK TRAINING ON WEIGHT-LIFTING PERFORMANCE

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[Introduction] Tests were performed to examine whether trunk training improved weight-lifting performance. [Subjects and Methods] The subjects were 30 high-school students (grades 10–12) who were weight-lifting club members. Eight exercises (three for static training and five for dynamic training) were selected from the popular trunk training program. The subjects trained for 2–4 months, 6 times a week. Before and after the training program, the subjects' snatch (S) and clean and jerk (C&J) weight-lifting performances were evaluated. Changes in the measurements, including growth rate, were compared between the subjects who did and those who did not undergo trunk training. [Results] The results of the trunk training program were as follows: The recorded levels of improvement in the training group were  $6.64 \pm 1.57$  kg for the S lift and  $6.68 \pm 1.50$  kg for the C&J lift, whereas those for the non-training group were  $0.63 \pm 0.38$  and  $1.75 \pm 0.67$  kg, respectively, indicating significant improvements for the subjects who underwent trunk training. [Discussion] Weight lifting is an isometric exercise where the level of performance is high when the movement of the center of gravity is minimized. Trunk training includes isometric exercise, which suggests that this experiment contributed to improved performance. [Conclusion] Through this study, the significant contribution of trunk training on the improvement of weight-lifting performance was clarified.

## PRESERVED CARDIOVASCULAR RESPONSE TO METABOREFLEX ACTIVATION IN NEVER-TREATED HYPERTENSIVE MEN

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Introduction Hypertensive rats have exaggerated pressor response to metaboreflex activation (2) but these findings are equivocal in humans (3, 4). Thus, we further assessed whether hypertensive men that had never been treated have increased metaboreflex responsiveness. Due to a possible specificity of pressor response according to muscle groups observed in cardiovascular diseases (1), isometric handgrip and leg cycling were tested. Methods Five never-treated hypertensive (HT;  $48 \pm 3$  years old,  $149 \pm 8/95 \pm 5$  mmHg) and 6 normotensive (NT;  $47 \pm 5$  years old,  $124 \pm 4/78 \pm 2$  mmHg) men had intra-arterial blood pressure (BP) and heart rate (ECG; HR) measured during muscle metaboreflex activation by post-exercise ischemia (PEI) after: 1) isometric handgrip at 40% maximal voluntary contraction; 2) leg cycling at 80 W. Responses to exercise were the difference between the last 30 s of PEI and resting baseline (BL). Results During PEI following handgrip, BP remained elevated (HT:  $+32 \pm 3$  mmHg vs. NT:  $+35 \pm 3$  mmHg;  $P < 0.05$  vs. BL), while HR returned to BL (HT:  $-1 \pm 2$  bpm vs. NT:  $-1 \pm 2$  bpm;  $P > 0.05$  vs. BL). During PEI following cycling, BP (HT:  $+28 \pm 4$  mmHg vs. NT:  $+24 \pm 4$  mmHg;  $P < 0.05$  vs. BL) and HR (HT:  $+28 \pm 7$  bpm vs. NT:  $+27 \pm 6$  bpm;  $P < 0.05$  vs. BL) remained elevated above BL. These responses to PEI of forearm and leg muscles were similar between groups ( $P > 0.05$ ). Discussion In line with a previous finding in humans (3), we showed that cardiovascular responses to metaboreflex activation of hypertensive men were not exaggerated compared to normotensive men, regardless of the muscle group involved. In comparison to conflicting evidence (4), we suggest that antihypertensive treatment and aging are important factors affecting metaboreflex responsiveness. References 1. Carrington CA, Fisher JP, Davies MK, White MJ. Muscle afferent inputs to cardiovascular control during isometric exercise vary with muscle group in patients with chronic heart failure. *Clin Sci (Lond)*. 2004;107(2):197-204. 2. Leal AK, Williams MA, Garry MG, Mitchell JH, Smith SA. Evidence for functional alterations in the skeletal muscle mechanoreflex and metaboreflex in hypertensive rats. *Am J Physiol Heart Circ Physiol*. 2008;295(4):H1429-38. 3. Rondon MU, Laterza MC, de Matos LD, Trombetta IC, Braga AM, Roveda F, Alves MJ, Krieger EM, Negrao CE. Abnormal muscle metaboreflex control of sympathetic activity in never-treated hypertensive subjects. *Am J Hypertens*. 2006;19(9):951-7. 4. Sausen MT, Delaney EP, Stillabower ME, Farquhar WB. Enhanced metaboreflex sensitivity in hypertensive humans. *Eur J Appl Physiol*. 2009;105(3):351-6.

## CAN TRANSCRANIAL DIRECT CURRENT STIMULATION CHANGE CARDIOVASCULAR RESPONSES AND GUN-SHOOTING PERFORMANCE IN POLICE OFFICERS?

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Introduction: Police officers need to improve precision and accuracy of shooting to minimize crime risks. Cardiovascular variables, such heart rate (HR) and blood pressure (BP), are controlled by autonomous nervous system and has been related to shooting performance. Transcranial direct current stimulation (tDCS) has shown to increase parasympathetic activity and decrease sympathetic activity. Therefore, tDCS might be able to improve shooting performance since it can changes autonomous nervous activity and decrease HR and BP. Purpose: Here we tested whether tDCS is able to affect cardiovascular responses and shooting performance in police officers. Methods: The sample was composed by 13 male police officers ( $33.2 \pm 4.3$  years;  $1.72 \pm 0.5$  m;  $79.5 \pm 7.2$  kg;  $26.7 \pm 1.4$  kg/m<sup>2</sup>;  $41.3 \pm 10.2$  ml.kg.min<sup>-1</sup>). After two sessions of familiarization of the gun (air shot gun 4,5 mm, Taurus®, Gamo P-900, 0,55 Kg) and test procedures, participants randomly performed three sessions with different tDCS conditions in a cross over design: anodal single lateral tDCS (A-tDCS), anodal bilateral tDCS (B-tDCS), and a sham tDCS (S-tDCS). An electric current of 2  $\mu$ A for 20 min using 35 cm<sup>2</sup> electrodes embedded in a salty solution applied in A-tDCS and B-tDCS conditions. In the S-tDCS session, the device was turned off after 30 seconds in order to deceive subjects. Before and after tDCS, heart rate variability (HRV), HR (Polar® RS800cx), BP (Omron® 742 INT), as well as gun-shooting accuracy, precision, score, and time were assessed. Results: A two-way repeated measure ANOVA (condition X time) showed that there was an effect of time in all conditions, with decreased HR ( $P \leq 0.003$ ) and increased DBP ( $P \leq 0.004$ ). There was no change in any index of HRV ( $P \geq 0.05$ ), SBP ( $P \geq 0.05$ ) as well as there was no effect on shooting accuracy ( $P \geq 0.2$ ), precision ( $P \geq 0.06$ ), score ( $P \geq 0.06$ ), and time ( $P \geq 0.3$ ). Conclusions: tDCS has no effect on cardiovascular measures and shooting performance of police officers. It is possible that the physical fitness level and the specific work context of police officers have influenced the tDCS effect.



## HEART RATE VARIABILITY AS A PREDICTOR OF FAILURE IN COGNITIVE PERFORMANCE

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**Introduction** Heart Rate Variability (HRV) is a reliable reflection of the autonomic nervous system's (ANS) influence on heart rhythm, and is sensitive enough to identify physiological and psychological responses (Strauss, 2003). Few studies have examined if HRV is sensitive enough to predict failure in cognitive performance under high levels of physiological and psychological stress. The aim of the study was to identify if HRV can predict performance failure in healthy males performing under stress. **Method** Eight healthy male subjects took part in a within subject, repeated measures design study. Subjects completed two experimental trials (low cognitive anxiety (LC); high cognitive anxiety (HC)) where the threat of shock was used to induce cognitive anxiety (Svebak et al., 1982). Pre and post testing subjects completed the Revised Competitive State Anxiety Inventory-2 (CSAI-2R; Cox et al., 2003). A 3-lead ECG was used to measure HRV (AD Instruments, PowerLab, Oxford, England). Subjects were submerged in water at 42°C up to the chest for up to 30 min to induce physiological stress. Cognitive performance was measured via the trail making test (Reiten, 1955) which was completed every 5 min. **Results** A 2-way-repeated measures ANOVA identified no significant difference between LC and HC conditions in HRV and performance measures ( $p > 0.05$ ); CSAI-2R did not differ significantly between the LC and HC conditions ( $p > 0.05$ ). A significant main effect was found in HRV over time with a decrease in SDNN, RMSSD, LFnu, SD1, SD2, and an increase in HFnu. Only three of the eight subjects suffered performance failure; in these subjects correlations were found between performance decrement and decreases in the HRV parameters SDNN ( $r = -0.4$ ), LF ( $r = -0.57$ ) and HF ( $r = -0.45$ ). **Discussion** Physiological stress was identified by decreased SDNN, RMSSD and HF(nu) over time, indicating parasympathetic nervous system withdrawal. Furthermore, increased LF(nu) over time illustrates increased SNS influence (Armstrong et al., 2012). Negative correlations were found between SDNN, LF, and HF and performance of subjects who suffered performance failure, providing support for the proposal that HRV can successfully predict performance change. Findings were limited by the cognitive performance test, which was not sensitive enough to identify performance change in all participants, and, by the stress protocol, which was not sufficient to induce changes in cognitive anxiety. **References** Armstrong R, Ahmad S, Seely A, Kenny G. (2012). *Eur J Appl Physiol*, 112, 501-511. Cox R, Martens M, Russell W. (2003). *J Sport & Ex Psych*, 25, 519-533. Reitan R. (1955). *J Consult Psych*, 19, 393-394. Stauss H. (2003). *Am J Physiol Regul Integr Comp Physiol*, 285, 927-931. Svebak S, Storjell O, Dalen K. (1982). *British J of Psych*, 73, 505-512.

## OXYGEN UPTAKE KINETIC IN WELL TRAINED ROAD- AND CROSS-COUNTRY CYCLISTS

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**Introduction** While road-cycling is mostly performed at a steady pace over an extended duration of time, the hilly terrain in cross-country cycling results in rapid shifts in exercise intensity. As a fast kinetic of oxygen uptake ( $\dot{V}O_2$ ) is essential for avoiding oxygen deficiency during the transient from low to high intensity (I), rapid  $\dot{V}O_2$  kinetics may be more important for performance in cross-country cycling than road cycling. We hypothesized that among cyclists of high national level and similar aerobic fitness, cross-country cyclists (CC) would have a faster  $\dot{V}O_2$  kinetic than road cyclists (RC). **Method** Eleven CC (17±1 years, 66±9 kg, 178±7 cm, 1 female) and nine RC (17±1 years, 70±9 kg, 182±8 cm, 1 female) participated in the study. All tests were performed on an ergometer cycle while respiratory gases were measured pulmonary. Blood lactate was sampled from the fingertip. Lactate threshold (LT) was defined as work intensity equal to blood lactate concentration of 4.0 mmol/L.  $\dot{V}O_{2max}$  and maximal aerobic power (MAP) was measured during a stepwise incremental test until exhaustion.  $\dot{V}O_2$  kinetics was measured as rate of increase in  $\dot{V}O_2$  when the cycling intensity increased from 20W to moderate intensity defined as 80% of LT. **Results** LT,  $\dot{V}O_{2max}$  and MAP were not different between the groups (CC: 264±56 W, 4.8±0.9 L/min and 339±67 W, respectively. RC: 268±66 W, 4.8±0.9 L/min and 344±69 W, respectively. All  $p > 0.05$ ).  $\dot{V}O_2$  at 20 W was 0.97 ±0.12 and 0.99 ±0.18 L/min for CC and RC, respectively ( $p > 0.05$ ). Exercise load at moderate intensity was 211±45 W and 215±53 W for CC and RC, respectively ( $p > 0.05$ ). Steady state  $\dot{V}O_2$  at moderate intensity was 2.1±0.5 and 1.9±0.6 L/min for CC and RC, respectively ( $p > 0.05$ ). The rate of increase in  $\dot{V}O_2$  from 20 W to moderate intensity (time taken to reach 63% of steady state,  $\tau$ ) was 10.3±2.4 and 11.7±2.9 s for CC and RC, respectively ( $p > 0.05$ ). Effect size measured as Cohen's d, was 0.53 between groups, which is considered as moderate effect for highly trained athletes (2).  $\tau$  did not correlate with  $\dot{V}O_{2max}$  ( $r = -0.26$ ), MAP ( $r = -0.01$ ) or LT ( $r = -0.05$ ). **Discussion** Though these results do not show a statistical difference, the numeric 12% faster  $\dot{V}O_2$  kinetic in the CC group together with the moderate effect size of difference in  $\dot{V}O_2$  kinetic, indicates that the rapid shifts in exercise intensity during cross-country cycling compared to road cycling may lead to a faster  $\dot{V}O_2$  kinetic in CC that is of practical importance. **References** 1 Burnley and Jones, *EJSS*, 2007; 7:63-79 2 Rhea, *JSCR*, 2004; 18:918-920

## PULSATING ELECTROSTATIC FIELD APPLICATION AND MUSCLE SORENESS DEVELOPMENT AFTER ECCENTRIC EXERCISE

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**Introduction** The aim of the study was to establish whether pulsating electrostatic field (PESF) application, shown to increase blood flow, metabolic activity and to function as an ion pump (Liani et al., 2014, De Lorenzo et al., 2004), is able to reduce muscle pain after exercise induced muscle damage. **Methods** Six participants (3 males, weight: 74.0±6.9 kg, height: 185.7±10.2 cm, age: 27.0±2.6 years; 3 females, weight: 71.0±5.3 kg, height: 172.3±6.4 cm, age: 24.3±1.2 years) performed two sessions of downhill running separated by at least 4 weeks. After the running sessions participants were either treated for 45 min with a negative PESF (NewHealth 9000 device, Akern srl, Pontassieve, Italy) at 9000V (current level: < 9mA, pulsatile frequency: 50Hz) or got a sham treatment. The order of the intervention was random and condition was blinded for the participants. Muscle soreness score (MSS) was established before, immediately after the run, immediately after the treatment and 24 and 48 hours after the run. Creatine kinase was measured before and 48 hours after the run and jump ability was assessed before, immediately after the treatment and 48 hours after the run. **Results** 48 hours after the downhill run, MSS tended to be less increased after PESF administration when compared to the sham setting ( $\Delta$  MSS: 3.2±2.2 vs. 5.7±3.4 after 48 h;  $p = 0.083$ ). No further differences were detected. **Discussion** Outcomes show that PESF might be a promising application to reduce muscle soreness after exercise induced muscle damage. PESF application might have induced some beneficial effects due to an increased blood flow caused by an augmented vasomotor activity (Liani et al., 2014). The increased blood flow might have enhanced the removal of edema, limited inflammation and reduced perception of pain (Hausswirth et al., 2011). Furthermore, PESF might have functioned as an ion pump and moved calcium ions. Increased calcium concentrations within the sarcoplasm may activate many different molecular pathways leading to breakdown of the cell membrane and myofibrils (McKune et al., 2012). However, further studies are needed to confirm

present outcomes and to establish the exact mechanism by which PESF may reduce muscle pain. References De Lorenzo A, Martinoli R, Carbonelli MG, Monteleone G, Di Lorenzo N, Di Daniele N. (2004). *Diab Nutr Metab*, 17, 309-312. Hausswirth C, Louis J, Bieuzen F, Pournot H, Fournier J, Filliard JR, Brisswalter J. (2011). *PLoS One*, 6, e27749. Liani M, Trabassi E, Cusaro C, Zoppis E, Maduli E, Pezzato R, Piccoli P, Maraschin M, Bau P, Cortese P, Cogo A, Salvati F, Liani R. (2014). *Prim Care Diabetes*, 8, 244-249. McKune AJ, Semple SJ, Peters-Futre EM. *Biol Sport*, 29, 3-10. Contact Hannes.gatterer@uibk.ac.at

### **A COMPARISON OF BODY MASS INDEX SCORES TO BODY FAT PERCENTAGE DERIVED FROM SKINFOLD MEASURES WITHIN THE AUSTRALIAN DEFENCE FORCE**

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**Introduction** Body Mass Index (BMI) scores have been used within the Australian Defence Force for decades, it's claimed to be the most effective means of assessing possible health related issues that may appear within an ADF career. Recruitment limits BMI at a ceiling of 32.9 in relation to health care expenses (Peake et al 2012) although this does not distinguish between lean muscle mass and body fat (De Lorenzo et al 2011). Therefore the aim of this study was to compare BMI and body fat percentage scores of current full-time ADF personnel to ascertain if BMI is an out-dated method of assessing health risks and body composition. **Methods** The study included 16 ADF personnel (8 males and 8 females) between the ages of 18-44 from all three services including the Royal Australian Air Force, Royal Australian Navy and Australian Army Corps. The participants had anthropometric measurements taken with Harpenden skinfold calliper's at 8 anatomical sites and BMI was derived from a stadiometer and Tanita scales with the formula weight/height<sup>2</sup>. The BMI scores were then further calculated to form body fat percentage (BF %) estimations. Pearson's correlation coefficient (r) was calculated using SPSS 19 to find any relationships between BMI, BF% calculated from BMI and BF% calculated from skinfold measures. Results A significant positive correlation was observed between BMI and BF% calculated from BMI and BF% calculated from skinfold measures in male participants (r=.95, p<.000 and r=.90, p<.002) however no correlations between BMI and calculated BF% from other methods were observed amongst females. The effect of age was significant in both groups relating to BF% calculated in females (r=.78, p<.023) and skinfold in males (r=.74, p<.036) and as a combined group to BF% from BMI (r=.76, p<.001). **Discussion** The use of BMI in the ADF as means of quantifying body fat estimations may have been valid when predominantly males enlisted; the modern defence force is diverse in culture and gender and measurement of body composition should reflect the changes. This study observed BMI calculated estimations of body fat percentages to be significantly correlated with the male personnel but not with the females, which in many cases over-estimated the body fat percentages of personnel with lower skinfold scores. BMI is therefore not an accurate reflection of body composition or health risk in the modern defence force. References De Lorenzo A, Duerenberg P, Andreoli A, Borg P, Kukkon-Harjula K, Van Marken Lichtenbelt WD (2001) *European Journal of Clinical Nutrition*, 55, 973-979. Peake J, Gargett S, Weller M, McLaughlin R, Cosgrove T, Wittert G, Nasveld P, Warfe P (2012). *BioMed Central*, 12, 451. Contact sarah.guajardo@cdu.edu.au

### **MALE JUDO ATHLETES WITH HIGHER BODY FAT PERCENTAGE CONTINUE TO HAVE HIGH SKIN TEMPERATURES AFTER THE MATCH**

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**[Introduction]** Competitive Judo is divided into 7 classes according to weight, with men divided into the following classes: <60 kg, 66 kg, 73 kg, 81 kg, 90 kg, 100 kg, and >100 kg. Body fat percentage increases with increasing weight class, with a particularly rapid increase in the >90 kg classes. The purpose of this study was to compare physiological changes before and after a Judo match between men <90 kg group and >90 kg group. **[Subjects and Methods]** This study included 15 men with >10 years of Judo experience who were divided into 2 groups: one is "<90 kg (n = 7)" and ">90 kg (n = 8)". Body composition (body fat percentage, skeletal muscle percentage, and extracellular water) was measured before the match, while heart rate, tympanic temperature, and skin temperature (Thigh, Tsurite, and Hikite temperatures) were measured before and 1, 10, and 20 min after the match. **[Results]** Body fat percentage in the >90 kg group (20.8 ± 2.3%) was significantly higher than the <90 kg group (11.6 ± 1.4%) (p < 0.01), while skeletal muscle percentage (p < 0.01) and extracellular water (p < 0.05) in the <90 kg group (50.1 ± 1.3% and 0.20 ± 0.003 L/kg, respectively) were significantly higher than the >90 kg group (43.7 ± 1.6% and 0.17 ± 0.007 L/kg, respectively). The Thigh, Tsurite, and Hikite temperatures measured 10 min after the match were significantly higher in the >90 kg group than the <90 kg (p < 0.05). There was significant correlation between body fat percentage and rate of change of Thigh (R<sup>2</sup> = 0.6288, p < 0.01), Tsurite (R<sup>2</sup> = 0.4173, p < 0.01), and Hikite (R<sup>2</sup> = 0.5372, p < 0.01) temperatures between 1 and 10 min after the match. **[Conclusions]** The results of this study demonstrate that male Judo athletes with higher body fat percentage continue to have high skin temperatures after the match.

### **EFFECT OF MUSCLE ACTIVITY ON ERECTOR SPINE, RECTUS FEMORIS, BICEPS FEMORIS, AND GASTROCNEMIUS IN ACCORDANCE WITH THREE FORWARD BENDING POSTURES DURING CYCLE-ERGOMETER EXERCISE**

Hu, Z., Park, J., Lee, H.

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**Introduction** The purpose of this study is to examine the differences of muscle activity on Erector spine, Rectus femoris, Biceps femoris, and Gastrocnemius according to three forward bending postures during aerobic exercise with cycle ergometer. **Methods** For achieving this purpose, 9 active male students in Sangmyung University were performed. This experiment was carried out with two measuring equipment. 9 subjects were asked to maintain three postures in bending angles from 0 to 90 degrees, performing the exercise at a given time. First posture is upright sitting posture. Second posture is forward bending posture. Third posture is upright standing posture. Three postures that the participants were going to perform were applied to each participant in the same order. Prior to placing the electrodes on the skin, the skin over the targeted muscle was shaved and cleaned with ethanol for the accurate muscle activity measurement (Albertus-Kajeeet al., 2010). As the EMG activity of the targeted muscles was recorded, subjects pedaled for 60 seconds at 70 rpm. TeleScan program by Laxtha was used to analyze the values of muscle activity and the values of MVIC (Kang al., 1999). Data on calculated values through TeleScan were calculated by SPSS/PC ver.18.00, analyzed using one-way analysis of variance to detect significant differences. Statistical significance was defined as p < 0.05. **Results** The data of three postures suggested that only Rectus femoris values in accordance with three postures showed significant differences statistically (p < .05). In case of upright standing posture, its posture more contributed to Rectus femoris than the other postures did during cycling. Also, this study demonstrated that no matter what postures subjects

biked in, four targeted muscles were significant differences in muscle activity. Conclusion In conclusion, as this study showed targeted muscle activity by each posture, three postures help Rectus femoris to use more than the other muscles. The results of this study supported to reconfirm the results of a preceding research by showing Vastus lateralis runs as one of major muscle groups during pedaling, and training volume remarkably increases during measuring EMG [Ericson et al., 1986; Komi et al., 1975]. Therefore, we recommend that trainers in the field should consider this result when they train people with cycle exercise (Lee et al., 2010). Furthermore, when we explore which posture burns more calories during cycle-ergometer exercise, the pre-study will help to measure up training volume. References Albertus-Kajee Y, Tucker R, Derman W, Lambert M. (2010). *J Electromyography and Kinesiology*, 20(6), 1036-1043. Lee S. (2010). Konkuk U Kang H (1999). Han Yang U Ericson, M. O, Bratt, A., Nisell, R., Arborelius, U. P, and Ekholm, J. (1986). *European J Applied Physiology*, Vol.55(3), pp.229-235. Komi, P. V., Vitasalo, J. H.(1975). *Acta Physiologica Scandinavia*, Vol.96(2), pp.267-276.

### THE EFFECTS OF ENDURANCE EXERCISE AND CALORIC RESTRICTION ON GEOMETRY AND DENSITOMETRY OF CORTICAL BONE IN ADULT MALE RATS

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Objective: The purpose of this study was to investigate the effects of calorie restriction and endurance exercise on cortical bone mineral density and geometry in adult male rats. Method: Sixty 26 weeks male Sprague Dawley rats (n=60) were randomly assigned to control (CON), 40% and 20% caloric restriction (CR40% and CR20%), endurance training (EXE) and pioglitazone (PIO) groups (n=12 for each group). The exercise intervention was consisted of a treadmill running training regime with running speed at 16 m/min, training duration 60 min/day and a training frequency of 5 days/week for nine weeks. Animals of the PIO group were oral fed by pioglitazone at a dose of 10mg/kg b.w./day. After euthanasia, femoral bones were collected and subjected micro computed tomography (microCT) scanning for densitometric and midshaft cross-section geometric analyses. Result: The CR40%, CR20% and EXE groups were significant lower in body mass as compared to the CON and PIO group (p <0.05). There is no difference in the absolute bone mineral density (BMD, g/cm<sup>3</sup>) and bone mineral content (BMC, mg). And, none of cross-sectional geometry measurements showed difference among groups. However, when indices further normalized to the body mass, the CON and PIO groups showed relatively lower values in most indices of densitometry (relative total and cortical BMD and BMC) as well as relatively lower cross-sectional parameters in midshaft femur (including: cross-sectional area, cortical thickness and moment of inertia, etc.) (p <0.05). Conclusion: Absolutely, adult male rats subjected to exercise, CR and pioglitazone treatment showed no different effects on cortical bone geometry and densitometry. However, the body weight reduction shown in exercise and CR groups made the bones of those animals relatively higher in cortical bone dimension and density.

### CAN A GENETIC PREDISPOSITION SCORE PREDICT CHANGES IN MUSCLE FUNCTION OVER A TEN-YEAR FOLLOW-UP PERIOD IN FLEMISH MIDDLE-AGED ADULTS?

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Introduction Ageing is a complex process that is accompanied with changes in both muscle mass and muscle function (strength and performance). These changes initiate in middle-age and are characterized by large inter-individual differences, determined by environmental and genetic factors. The aim of this study was to examine the power of a genetic predisposition score (GPS), based on 18 candidate polymorphisms linked with muscle phenotypes (a.o. ACTN3, GDF8, VDR), to predict changes in muscle function over a 10-year follow-up period in Flemish middle-aged adults. Methods Data were assessed within the framework of the first (2002-2004: baseline) and third generation Flemish Policy Research Centre Sport (2012-2014: follow-up). A total of 117 healthy, Flemish Caucasian adults (39-49, 73.5% men) were measured during a follow-up period of  $9.59 \pm 0.47$  years (Mean  $\pm$  SD). Force and velocity characteristics of the knee extensors were measured using the Biodex Medical System 3® dynamometer. Isometric strength of the knee extensors (Nm) was assessed at a knee joint angle of 120° (ISOM120°). Isometric knee extension strength (Nm) was examined at a low velocity of 60°/s (ISOK60°) and at a high velocity of 240°/s (ISOK240°). Two models for a genetic predisposition score (GPS) were designed: a total GPS (based on the sum of all 18 variants, each favorable allele = score 1) and a data-driven GPS (sum of favorable alleles of those variants with significant b-coefficients in stepwise regression). Both GPS models were used to predict 10-year changes in muscle function via linear regression analysis. Results The total GPS was able to explain 26.8% of the variance in changes in ISOM120° in women (beta = -0.52, P = 0.0034), but not in men. The regression equation of the data driven GPS for ISOM120° was based on two polymorphisms (CNTFR rs3808871, PPP3R1 rs11692815). This regression model was able to predict changes in ISOM120° (beta = -0.18, P = 0.0486, r<sup>2</sup> = 0.0334, total group), with up to 13.8% explained variance in women separately (beta = -0.37, P = 0.0396). No GPS model was able to predict changes in isokinetic strength at either of both speeds. Conclusions A GPS based on 18 gene variants contributes to predict age-related changes in isometric strength, however only in women. Furthermore, gene variants in PPP3R1 (calcineurin B) and CNTFR (Ciliary Neurotrophic Factor Receptor) are significantly related to loss of isometric strength in both men and women. Contact ruben.charlier@faber.kuleuven.be

### EFFECT OF MODERATE AEROBIC EXERCISE ON MOTOR LEARNING

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Introduction Regular participation in physical activity has been associated with improved cognitive functions across the lifespan and would help in preventing cognitive decline and dementia. Aerobic exercise of moderate intensity has been shown to elicit increment in concentrations of brain-derived neurotrophic factor, that would enhance brain plasticity. Executive functions, learning and memory processes could therefore result improved. Our aim was thus to evaluate the effect of a single bout of aerobic exercise on motor learning, as measure of brain plasticity. Methods Thirty-eight healthy males (age:  $23 \pm 2$  yrs, mean  $\pm$  SD) were randomly assigned to an exercise-group (exe-group; n=19) or a control group (ctrl-group; n=19). All subjects exercised on a cycle-ergometer for 30 min: exe-group pedaled at an intensity eliciting 70% of individual maximal heart rate (HR), ctrl-group pedaled at 20 W, i.e. an almost unloaded task. The subjects were administered a motor task (MT), which consisted of performing a sequence of 64 abduction movements with the left thumb as fast as possible. MT was carried out before (block-pre) and six times after the exercise (block1, 2, ..., 6). Movement acceleration was continuously recorded, then the mean peak value for each block was calculated and normalized to block-pre. HR was continuously recorded throughout the experiment. Results At the end of cycle task HR in exe-group was  $148 \pm 13$  b/min, corresponding to a mean increase of 75 b/min above resting value. In the initial 2 min of recovery HR dropped by about 50 b/min and then further slowly decreased. In ctrl-

group, a slight increase in HR (10-12 b/min) was observed during pedaling. In exe-group, movement acceleration showed a continuous increment from block1 to block6 (+ 30% on average;  $p < 0.05$ ). In contrast, in ctrl-group only a tendency to improve the motor performance was found, being movement acceleration in all blocks significantly lower than in exe-group. Discussion Performance in motor task progressively enhanced in the recovery after the dynamic exercise. This would indicate that a single bout of aerobic muscular work does boost the process of motor learning. Thus, suggestion can be made that acute exercise, at least of moderate intensity, can have an influence on brain plasticity. [renza.perini@unibs.it](mailto:renza.perini@unibs.it)

## EFFECTS OF INTERVAL VS. CONTINUOUS EXERCISE ON ACUTE PHYSIOLOGICAL RESPONSES IN PATIENTS WITH TYPE 1 DIABETES MELLITUS

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**Introduction** Aerobic high-intensity interval exercise (HIIE) is an integral part of prevention in individuals with Type 1 Diabetes Mellitus (T1DM). The aim of this study was to compare the acute metabolic and cardiorespiratory response to short HIIE vs. moderate continuous exercise (CE) in T1DM patients. **Methods** 7 trained male subjects with T1DM (age:  $24.7 \pm 5.3$  years, height:  $1.76 \pm 0.40$  m, weight:  $74.0 \pm 5.1$  kg) adapted to ultra-long-acting basal insulin initially conducted an incremental exercise test (IET) to determine maximal power output ( $P_{max}$ ) and the first (LTP1) and second (LTP2) lactate turn point. Then they performed short HIIE and CE matched for mean load ( $P_{mean}$ ) and duration (30 min) at three different mean loads: 5 % of  $P_{max}$  below PLTP1 (A), 5 % of  $P_{max}$  above PLTP1 (B), and 5 % of  $P_{max}$  below PLTP2 (C). In HIIE, peak workload ( $P_{peak}$ ) was  $P_{max}$  from IET, peak workload duration ( $t_{peak}$ ) was 20 s, and recovery duration ( $t_{rec}$ ) was 120 s for A, 60 s for B, and 20 s for C. Recovery load ( $P_{rec}$ ) was calculated. Blood lactate concentration (La), heart rate (HR), and gas exchange parameters were measured. Insulin and bread units were adapted according to standard guidelines. For comparison between CE and HIIE, a paired t-test was used. **Results** Mean values for La and respiratory exchange ratio (RER) were significantly higher in HIIE compared to CE ( $P < 0.05$ ) in A (La:  $1.67 \pm 0.50$  vs.  $0.96 \pm 0.41$  mmol/l; RER:  $0.92 \pm 0.03$  vs.  $0.87 \pm 0.03$ ) and B (La:  $2.08 \pm 0.64$  vs.  $1.33 \pm 0.48$  mmol/l; RER:  $0.93 \pm 0.03$  vs.  $0.89 \pm 0.03$ ) but not in C (La:  $4.93 \pm 1.80$  vs.  $4.75 \pm 1.53$  mmol/l; RER:  $0.94 \pm 0.03$  vs.  $0.93 \pm 0.03$ ). In each test, a La steady state was found. There were no significant differences between HIIE and CE at all mean intensities for average HR (A:  $106.4 \pm 11.1$  vs.  $105.8 \pm 7.0$ ; B:  $117.5 \pm 9.3$  vs.  $120.2 \pm 7.6$ ; C:  $161.8 \pm 8.8$  vs.  $164.7 \pm 9.6$  b/min) and oxygen uptake (A:  $1.32 \pm 0.25$  vs.  $1.33 \pm 0.23$ ; B:  $1.59 \pm 0.29$  vs.  $1.61 \pm 0.35$ ; C:  $2.94 \pm 0.40$  vs.  $3.01 \pm 0.40$  L/min). All subjects were euglycemic before, during, and after all tests. **Discussion** Despite markedly higher  $P_{peak}$  in short HIIE, this exercise mode gave similar acute physiological responses compared to moderate  $P_{mean}$ -matched CE, particularly for high mean load (C). The similar RER values in HIIE vs. CE for C suggest that the overall response is the same for short HIIE and CE although markedly higher peak workloads in the intervals. Acute responses and training adaptations induced by HIIE applying different peaks vs. CE have to be investigated in further mechanistic and randomized controlled training studies. Contact [gerhard.tschakert@uni-graz.at](mailto:gerhard.tschakert@uni-graz.at)

## BIOCHEMICAL ASSESSMENT OF MUSCLE DAMAGE AFTER MOUNTAIN TRAIL RACES

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**Introduction** Mountain trail races (MTR), or >42km Mountain Ultramarathons (MUM); are competitive runs that involve a great cumulative elevation gain (Easthope et al., 2011). There is general agreement that MTR leads muscle damage, due to strenuous competitive conditions and the eccentric contractions during the downhill phases (Millet et al., 2012). This study aimed to test the effects of different distances in the induction of muscle damage. **Methods** One group ( $n=10$ ) of amateur trained men who ran a 35km MTR and another group ( $n=6$ ) of highly trained men who ran a 55km MUM volunteered for the study. Serum biomarkers of muscle damage, including CK, CK-MB, Mitochondrial-CK (Mt-CK), AST, ALT, cardiac troponin I (cTnI) and slow myosin (SM) and fast myosin (FM) isoforms were assessed before (pre), 1 hour after finishing (post), and 24 and 48 hours after the beginning of the races. A repeated measures analysis of covariance (ANCOVA) was done, including training hours per week as covariate. **Results** CK, CK-MB, Mt-CK and AST activity of both groups showed significant increases ( $p < 0.01$ ), peaking between 24h – 48h. The response was much higher in the 55km group than in the 35km group, for CK (164%) at 1h post, and for CK-MB (251% and 147%) at 1h and 24h respectively. Increases of CK, CK-MB and AST registered 1h after the competition, were correlated to SM serum values obtained at 24h. SM was significantly increased at every time point analysed following competition for the 55km group, with a peak at 48h; but no significant changes from baseline were seen in the 35km group. FM showed no significant changes from baseline values in both groups; however, values were significantly higher in the 55km group throughout the experimental period, even at the pre value. A significant cTnI peak was found in the 55km group at 1h post, returning to baseline values at 24h. No significant changes were seen in the cTnI for the 35km group at any time point. **Discussion** Distance was the main determinant of SM release, signifying sarcomere damage of slow fibres following a MUM, even when highly trained athletes perform it. SM serum first changes obtained at 24 hours were correlated to CK, CK-MB and AST activities registered 1h post competitions. cTnI was only significantly elevated following the 55km MUM. **References** Easthope CS, Hausswirth C, Louis J, Lepers R, Vercruyssen F, Brisswalter J. (2010). *Eur J Appl Physiol*, 110(6), 1107-1116. Millet GY, Tomazin K, Verges S, Vincent C, Bonnefoy R, Boisson RC, ..., Martin V. (2011). *PLoS One*, 22;6(2):e17059 Funded by Institut Nacional d'Educació Física de Catalunya (INEFC) and MICIN DEP2013- 46574-P

## ASSOCIATION BETWEEN RIGHT VENTRICULAR METABOLISM AND EXERCISE CAPACITY IN HEALTHY MIDDLE-AGED MEN

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**Introduction** Previous cross-sectional studies have shown that athletes with high exercise capacity have lower insulin-stimulated left ventricular (LV) glucose uptake (GU) yet rather similar LV free fatty acid uptake (FFAU) compared to sedentary individuals (Nuutila et al. 1994, Takala et al. 1999a, Takala et al. 1999b). However, it is not known whether also right ventricular (RV) metabolism is similarly related to exercise capacity. Here we aimed to study the association between RV metabolism and exercise capacity in healthy sedentary middle-aged men. **Methods** Overall 28 healthy, previously sedentary middle-aged men were recruited for the study (age 40 to 55 years, mean BMI  $26.1$  kg/m<sup>2</sup>). A maximal-graded exercise test with direct respiratory measurements was performed on a bicycle ergometer. The RV

GU was measured using FDG-PET during euglycemic hyperinsulinemic clamp, and RV FFAU was determined by FTHA-PET. Structural and functional parameters were determined by cardiac magnetic resonance (CMR). Results The mean VO<sub>2</sub>max for the study subjects was 34 ml/kg/min (95% CI 33,36), mean RV GU during clamp 12 μmol/100g/min (11,14), and the mean RV FFAU at rest 1.7 μmol/100g/min (1.5,1.9). CMR-assessed mean RV end-diastolic volume (EDV) for the study subjects was 170 ml (159,180), mean RV end-systolic volume (ESV) 66 ml (59,73), and mean RV ejection fraction (EF) 62% (59,64). RV GU correlated negatively with age ( $r=-0.43$ ,  $p=0.03$ ) but not significantly with VO<sub>2</sub>max, RV FFAU, BMI, RV EDV, RV ESV, or RV EF%. RV FFAU correlated positively with HR<sub>rest</sub> ( $r=0.44$ ,  $p=0.03$ ), RV EF% ( $r=0.51$ ,  $p=0.02$ ) and negatively with RV ESV ( $r=-0.46$ ,  $p=0.03$ ) and VO<sub>2</sub>max ( $r=-0.44$ ,  $p=0.03$ ). Discussion Our results show that resting RV FFAU, rather than RV GU, correlates negatively to exercise capacity in sedentary middle-aged men. This adds to previous findings of lower LV GU and similar LV FFAU in trained compared to sedentary subjects. However, more confirmatory studies including exercise interventions in sedentary subjects are needed to better clarify the real training effects on RV glucose and fat metabolism. References Nuutila et al. (1994). *J Clin Invest*, 2267-2274. Takala et al. (1999a). *Am J Physiol*, 277, E585-E590. Takala et al. (1999b). *Am J Physiol*, 276, E706-E711. Contact [tuija.helena.leskinen@tyks.fi](mailto:tuija.helena.leskinen@tyks.fi)

### EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING ON THE RIGHT VENTRICULAR GLUCOSE AND FATTY ACID METABOLISM IN HEALTHY MIDDLE-AGED MEN

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Introduction The adaptations to exercise training in the heart have mostly been studied regarding the left ventricle (LV) and the effects on right ventricle (RV) are incompletely known. A recent meta-analysis showed that in prolonged intense exercise, especially the right ventricular function is compromised while the left ventricle remains relatively unaffected (Elliott & La Gerche, 2014), underlining the need to study RV adaptations to exercise. We compared the effects of short-term high-intensity interval training (HIT) and moderate-intensity training (MIT) on right ventricular glucose and fatty acid metabolism and function in healthy middle-aged men. Methods Twenty-eight untrained, lean and healthy men of age 40-55 years were randomized into HIT ( $n = 14$ ) and MIT ( $n = 14$ ) groups. Both groups had six training sessions within two weeks. Within a session HIT group performed 4-6 x 30 s "all out" cycling effort with 4 min recovery between bouts (Burgomaster et al, 2005) and MIT group cycled for 40-60 min at 60% VO<sub>2</sub>max. Glucose uptake (GU) of the free wall of the RV was measured using FDG-PET (during euglycemic hyperinsulinemic clamp) and free fatty acid uptake (FFAU) was measured with FTHA-PET (without clamp) before and after the training intervention. Cardiac MRI was performed to measure structural and functional parameters of RV. Results RV GU decreased ( $p=0.001$  for the training effect) after both HIT (-22 %) and AET (-15 %), but not statistically differently between the groups ( $p=0.6$  for the group\*training interaction). FFAU was not affected by training (HIT 0 %, MIT +1 %,  $p = 0.97$  for the training effect). Also RV ejection fraction (EF) and end-diastolic and end-systolic volumes (EDV and ESV) did not change significantly ( $p>0.05$  for the training effect). Discussion Correspondingly with the cross-sectional studies showing decreased insulin-stimulated glucose uptake in the left ventricle in the trained state (Takala et al 1999), also RV GU decreased by training and similarly between HIT and MIT. In line with our previous study (Hannukainen et al. 2007), we did not observe changes in FFAU neither by HIT or MIT. Also RV EF, RV EDV, and ESV remained unchanged after the training. The results suggest that in the RV glucose metabolism adapts to training first, thereafter possibly followed by structural and functional adaptations. References Burgomaster KA et al. *J Appl Physiol*, 2005, 98, 1985-90. Elliott AD & La Gerche A. *Br J Sports Med*, 2014, epub ahead of print. Hannukainen JC et al. *J Physiol*. 2007, 578, 347-58. Takala TO et al. *Am J Physiol*, 1999, 277, E585-90. Contact [marja.heiskanen@utu.fi](mailto:marja.heiskanen@utu.fi)

### EFFECTS OF UPHILL AND DOWNHILL WALKING ON THE DEGREE OF MUSCLE PAIN OF THE LOWER EXTREMITIES AFTER EXERCISE

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Purpose: The purpose of this study was to clarify the effects of uphill and downhill walking on the degree of muscle soreness after exercise. Methods: The subjects were six healthy Japanese males (age: 22.2±1.8 years, height: 169.9±6.9 cm, weight: 65.0±8.1 kg, BMI: 22.6±3.3). Each subject signed an informed consent form. The subjects were holding the rest sitting position of five minutes. Then, the subjects walked on treadmills for 30 minutes (Walking speed: 3.0 km/h, the weight of the backpack: 15% of body weight). The exercise conditions were the uphill-condition (slope: 10%) and downhill-condition (slope: -10%). Measurement items were heart rate, oxygen uptake, blood pressure, Rate of Perceived Exertion (RPE) and rectal temperature. We carried out a measurement every 5 minutes from the time the subject started the exercise. Fatigue and muscle soreness of the lower extremities were measured before exercise and after exercise (immediately after, one day later, two days later, three days later, four days later and five days later). Measurement of fatigue and muscle soreness of the lower extremities was carried out using the visual analog scale. Results and Discussion: The weight of the backpack during exercise was 9.7±1.2 kg. Heart rate and oxygen uptake during the downhill-condition were significantly lower than the uphill-condition ( $p<0.05$ ). Systolic blood pressure, RPE and rectal temperature showed no significant differences between the two conditions. Diastolic blood pressure during the downhill-condition of exercise at 15 and 20 minutes were significantly lower than the uphill-condition ( $p<0.05$ ). Fatigue of the lower extremities showed no significant difference between the two conditions. Muscle soreness in the uphill and downhill-conditions appeared immediately after the end of the exercises. Muscle soreness in the uphill-condition disappeared after one day of exercise. On the other hand, muscle soreness in the downhill-condition disappeared after two days of exercise. Moreover, the degree of muscle soreness immediately after exercise in the downhill-condition was significantly higher than in the uphill-condition ( $p<0.05$ ). From these results one can say that it is necessary to ensure for more rest after downhill walking than for rest after uphill walking. Conclusion: Loss of muscle soreness during downhill walking was delayed as compared to uphill walking. Moreover, the degree of muscle soreness immediately after downhill walking was significantly higher as compared to the uphill walking.

### THE AEROBIC CAPACITY AND IT'S RELATIONSHIP WITH ANTHROPOMETRIC MEASUREMENTS AND HEART RATE RESERVE FOR SECOND STAGE STUDENT OF SPORT SCIENCE COLLEGE

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the purpose of this study was to estimate VO<sub>2</sub>max and it's relationship with anthropometric measurements and heart rate reserve for second stage student of sport sciences college to identify the role of the subjects in college and its impact to development the fitness

level. Methods :Two groups of seventeen Males and sixteen females university student at the second stage of sport college , thirty of them were completed the study, the characteristics of males (age  $21.4 \pm 1.57$  years; mass  $65.5 \pm 6.16$  kg;high  $176.8 \pm 5.97$ ) mean  $\pm$  s.d, and the characteristics of females,(age  $20.42 \pm 1.39$  years; mass  $60.42 \pm 2.63$  kg;high  $164.28 \pm 4.85$ ) mean  $\pm$  s.d. Measurements were made of VO<sub>2</sub>max, somatotype (SPE),heart rate reserve(HRR),body mass(BM), body fat(BF) and energy consumption by calorie(CAL).This study was performed according to the guidelines set by the single stage treadmill walking test is a sub maximal aerobic fitness test. Results :There are no significant differences between males and females in all the study variables except (BF) that found greater in females than in males at level ( $P < 0.05$ ). on the other hand positively correlated with both VO<sub>2</sub>max and CAL in female, However, VO<sub>2</sub>max was not correlated in female with another variables, but there are many positively correlated in this study between each of the SPE and (HRR ,BM,BF and CAL ). While VO<sub>2</sub>max positively correlated were found in male with HRR, however VO<sub>2</sub>max was not correlated in male with another variables, but there are many positively correlated in this study between SPE with (HRR and BM),and BM with BF. Conclusion: there were significant differences between male and female of BF measures .Furthermore, it has been identified that mesomorphy is positively correlated with level of ability. We found that VO<sub>2</sub>max related with the amount of calorie spending during the physical effort in female.

#### VARIABILITY OF HEART RATE OF ELITE ATHLETES AT THE VALSALVA TEST

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Introduction Vegetative nervous system (VNS) plays important role in regulation of adaptation to intensive physical load. One of the informative noninvasive methods of study of VNS is analysis of variability of heart rate at the Valsalva test (VHR at VT). This test is an integral indicator of sympathetic and parasympathetic mechanisms of the baroreflex. Goal of the study was to compare VHR at VT of elite athletes and young male non-athletes. Methods Twenty-five elite judoists (experimental group) and fifteen healthy young male non-athletes (control group) have been examined. VHR at VT was registered with use of hard- and software complex VNS-Spectrum The study protocol included a 65-second registration of ECG in supine position. A few seconds after the start of ECG recording a person took a breath and made an effort for 20 seconds maintaining the intra-lung pressure at the level of 40 mm Hg under the control of manometer. Valsalva coefficient was calculated at processing of the rhythmogram (ratio of R-Rmax interval after the test to the R-Rmin during the test). A normal finding should be above 1.7. Lower tolerable values are around 1.30-1.70. Results In athletes the Valsalva coefficient was  $1.83 \pm 0.06$  which corresponds to optimal status of VNS. The control group had the Valsalva coefficient of  $1.57 \pm 0.11$ . This value shows the necessity of improving the functional status of individuals in the control group. VHR at VT was higher in the experimental group that evidences to the better adaptation of athletes to the changing conditions of external and internal environment. Simplicity and quickness of the procedure makes this method quite useful for effective control of workout process. Conclusion Follow-up of the test results provides a correct assessment of variations of the body's functional status and its adaptation reserves. The test allows identifying among the athletes those with excess stress of regulatory systems and increased risk of adaptation failure.

#### RELATIONSHIP BETWEEN BONE MINERAL VALUES AND LEG ANAEROBIC POWER IN PROFESSIONAL WRESTLERS AND UNTRAINED MEN

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Introduction In human, the absolute lean mass of the lower extremities was linearly related to the peak and average power. However, little is known about the relation between anaerobic power and bone mineral values in professional wrestlers. Therefore, the purpose of the present study was to investigate the relation between bone mineral values and anaerobic power in professional wrestlers. Methods A total of 14 male wrestlers ( $22.9 \pm 3.4$  yr) and 11 untrained men ( $24.5 \pm 1.6$  yr) were studied cross-sectionally. A total body scan was performed using dual-energy X-ray absorptionmetry (QDR-Explorer, Hologic, USA) to determine total and regional body composition. A 30-s Wingate test was conducted to measure performance of peak and average power. Pearson's correlation was calculated to explore the association between anaerobic power and bone mineral values as well as lean mass for both legs. Results Compared to the untrained men, the wrestlers had greater leg lean mass, BMC and BMD, and lower fat percentage. The average power (W and  $W \cdot kg^{-1}$ ) in untrained men was significant lower than wrestlers (both  $p < 0.01$ ). Average power (W) was correlated with leg lean mass in both groups. Peak power and average power (W) were notably associated with leg BMC and BMD in wrestlers ( $r = 0.608-0.717$ ,  $p = 0.021-0.004$ ), but less significant in untrained men. Peak power and average power ( $W \cdot kg^{-1}$ ) were associated with leg BMD in wrestlers ( $r = 0.616$ ,  $p < 0.05$ ;  $r = 0.641$ ,  $p < 0.05$ , respectively), but not in the control group. The positive relation between peak power and average power ( $W \cdot kg^{-1}$ ) variables and leg BMC exhibited a reliable trend in the wrestlers. Discussion It was well documented that the absolute measure of leg maximal power was associated with BMC and BMD at different sites in the adolescent girls (Witzke and Snow, 1999). Previous study (Haydari et al., 2010) showed a positive relationship between femoral neck and trochanter BMC and BMD variables and anaerobic power (Sargent jump test) in professional jumpers. It was also reported that 300-m running speed correlated with BMC and BMD variables in young female handball players (Vicente-Rodriguez et al., 2004). In the present study, we found the professional wrestlers' anaerobic power positively associated with bone mineral values, especially BMD; The positive association between BMD and anaerobic power were exhibited not only in the absolute measure of power but also in the relative values. Hence, our data provided support for this notion, and further contribute to, existing observations showing that the wrestlers showed positive correlations between BMD and anaerobic power in the relative values. References Witzke KA, Snow CM. (1999). *Med Sci Sports Exerc*, 31(11):1558-1563. Haydari M, Rahnama N, Khayambashi K, Marandi M. (2010). *Br J Sports Med*, 44(Suppl 1):i5-i5. Vicente-Rodriguez G, Dorado C, Perez-Gomez J, Gonzalez-Henriquez JJ, Calbet JAL. (2004). *Bone*, 35(5):1208-1215. Contact whoomin@hotmail.com

#### CONTROVERSIES IN ATHLETES ELECTROCARDIOGRAPHIC INTERPRETATION ACCORDING TO THE MAJOR GUIDELINES - THE SEATTLE CRITERIA AND THE RECOMMENDATIONS FOR INTERPRETATION OF 12-LEAD ECG IN THE ATHLETE, 2010

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Introduction. To measure the QTc interval in elite endurance athletes, and to compare the electrocardiographic interpretation according to the two major screening methods - The Seattle Criteria(2) and the Recommendations for Interpretation of 12-Lead Electrocardiogram in

the Athlete 2010.(1) Method. Preparticipation Screening: 347 highly trained athletes ( 285 M, 73 %) age  $21 \pm 3$ yo. Caucasians. Sports: rowing, canoeing. Clinical exam and personal/family history. 12 lead electrocardiogram(ECG). Each ECG was read according to the (A) the Seattle Criteria and (B) the Recommendations for Interpretation of 12-Lead Electrocardiogram in the Athlete. Long QTc (A):  $\geq 470$ ms(M),  $\geq 480$ ms(F); (B):  $\geq 440$ ms(M),  $\geq 460$ ms(F). Short QTc: (A)  $\leq 320$ ms; (B):  $\leq 380$ ms. Echocardiography (2D,Doppler, TDI). Cardiology exam and specific tests when required. Results: Height  $176.27 \pm 6.74$ cm; weight  $70.37 \pm 8.88$  kg; BMI  $1.59 \pm 0.15$ . Long QTc interval 2010 Recommendations ( $\geq 440$ ms) vs  $\geq$  Seattle ( $\geq 470$ ms): 9c vs 5c. Short QTc interval 2010 Recommendations ( $\leq 380$ ms) vs Seattle ( $\leq 380$  ms): 53c vs 13c. Discussion. According to (A) and (B), 80 athletes had abnormal QTc interval. The most frequent abnormalitie was the short QTc int (66 cases) from which, 53, were diagnosed by the 2010 Recommendations (QTc  $\leq 380$ ms). The cardiac evaluation performed in all athletes, revealed only one athlete with congenital short QT syndrome. References 1. Corrado D, et al. Recommendations for Interpretation of 12-Lead Electrocardiogram in the Athlete, 2010. Eur Heart J, 2010; 31: 243-259 2. J. A Drezner et al: Electrocardiographic interpretation in athletes: the "Seattle Criteria". Br J Sports Med 2013; 47: 122- 124 3. J.A Drezner, V. Froelicher et al: Normal electrocardiographic findings: recognizing physiological adaptations in athletes Br J Sports Med 2013, 47: 125-136 4. S. Sharma, M. Papadakis: Interpreting the Athlete's EKG: Are All Repolarizations Anomalies Created Equal?. Circulation 2015; 131: 128-130 5. M M Wasfy et al. ECG findings in competitive rowers: normative data and the prevalence of abnormalities using contemporary sceening recommendations. Br Sports Med 2015; 49: 200-206 6. P Bjeregaaard: Short QT Syndrome in "Electrical Diseases of the Heart. I.Gussak, C. Antzevitch ed. Springer 2008. 7. M J Ackerman: Congenital Long QT Syndrome "Electrical Diseases of the Heart I.Gussak, C.Antzevitch ed. Springer 2008. Do not insert authors here

## ATTITUDES & PRACTICES OF RECOVERY IN ASIAN YOUTH ATHLETES

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Introduction Exercise adaptations to training and recovery have been extensively studied in adults. Studies in youth populations are limited for ethical and practical reasons. Furthermore, sports academies have developed to provide full time coaching structures to developing athletes. Recovery practices in youth athletes across the world are often influenced heavily by coaches and their experiences of training adults or imparting adult practices upon youths. Therefore, the purpose of this study was to establish current practice and attitudes towards recovery in youth athletes. Methods Athletes were surveyed during participation in an Asian Olympic Youth Athletics Camp (n=48) or within their training environment at the Aspire Academy (n=41). A comparative sample of athletes of similar ages in the UK was made via email (n=53). Athlete's ages ranged from 13-18 years with 86% male across the groups. An online questionnaire was conducted with the three groups to assess practice and attitude to recovery. Results Athletes in Asia and the UK believe sleep and nutrition to be the most important recovery factors compared to contrast, active recovery, ice and compression. Attitudes towards recovery differed between athletes in Asia and the UK with the respect to the perceived benefits of sleep (88% believe in it in the UK v 67% in Asia, X2 16.5, p<0.01, ES=0.9), nutrition (92 v 58%, X2 19.0, p<0.01, ES=0.66), active recovery (70 v 51%, X2 5.09, p=0.02, ES=0.28) and compression (43 v 25%, X2 5.0, p=0.02, ES=0.46). The number of recovery techniques used with Asian athletes is higher after training (ES=0.5) and competition (ES=1.49). There is no increased use of technology to measure recovery in either the Asian or UK groups (X2 0.74, p=0.39). An analysis of open answers suggests Asian athletes rely more on 'feel' to justify recovery. Cluster analysis of the combination of techniques suggests that recovery attitudes can be clustered into 4 main groups at a similarity level of 50%. These can be summarised as; Traditional (where using active recovery, nutrition & sleep predominate), Intervention-based (stretching, cold & compression), Nutrition-based (stretch & nutrition) and Basic (sleep & active recovery). Within Asia, the Traditional approach dominates (76%) whereas in the UK Nutrition-based (38%) just exceeds Traditional (34%; X2 28.0, p<0.01). The reasons why these groups do what they do differs (X2 8.5, p=0.01) with 49% favouring experience in Asia and 60% in the UK favouring a combination of evidence and experience. Analysis of the open answers suggests behaviour in Asia is ruled by what the coach says and in the UK by educated self-decision. Discussion There are different beliefs in the benefits of sleep, nutrition, active recovery and compression but it seems that youth athletes still favour active recovery, nutrition and sleep. They may do this for different reasons as coaches seem to dictate to athletes more in Asia. This suggests there is a need to understand the evidence base for current recovery practices in a youth population.

## CLINICAL EFFECTS OF TRIATHLON EVENT ON CARDIAC BIOMARKERS

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The purpose of the present study was to investigate cardiac damage biomarkers after a triathlon race in elite and non-elite athlete groups. Fifteen healthy men participated in the study. Based on performance, they were divided in elite athlete group (EG: n= 7) and non-elite athlete group (NEG: n= 8). Participants blood samples were obtained in four periods: before, immediately, 2 hours and 7 days after finishing the race. Creatine kinase (CK), creatine kinase-myoglobin (CK-MB), myoglobin, and lactate dehydrogenase (LDH) were significantly increased in both groups immediately, and 2 hours after finishing the race (p<.05). CK, CK-MB, and myoglobin were completely recovered after 7days (p<0.05). Hematocrit was significantly decreased in both groups (p<0.05) 7 days after the race. LDH was significantly decreased in the EG (p<0.05) only 7 days after the race. Although cardiac troponin T(cTnT) was significantly increased in the EG but not in the NEG 2hours after the race (p<.05), there was no group-by-time interaction. cTnT was completely recovered in both groups 7 days after the race. In conclusion, cardiac damage occurs during a triathlon race and, is greater in elite than in non-elite. However, all cardiac damage markers return to normal range within 1 week.

## FORCE PRODUCTION AND COINCIDENT TIMING ACCURACY DURING RAPID GRIPPING AT DIFFERENT TARGET VELOCITIES IN BALL GAME PLAYERS

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Introduction Many ball game sports require precise rapid force production and accurate timing to hit or catch an oncoming target. This study aimed to clarify the accuracy of force production and coincident timing during rapid gripping at different oncoming target velocities of ball game players and non-players. Methods Twenty young adults (12 ball game players and 8 non-players) participated in this study. The participants performed rapid gripping to coincide with the arrival of a moving target using a horizontal electronic trackway (length, 4 m). The target moved at a constant velocity, and three different velocities (4 m/s, 8 m/s, and 12 m/s) were randomly produced. The grip

force required was 30% of the maximal voluntary contraction (MVC). The peak grip force (PF) and time to peak force (TP) were measured. The two types of errors observed in the force and timing were analysed to evaluate the accuracy of force production and coincident timing. A constant error (CE) of force and timing was obtained by subtracting the PF from the target force (30% MVC) and the target arrival time from the TP, respectively. An absolute error (AE) was obtained from the absolute values of the differences between the PF and target force and between the target arrival time and TP. Results The CE and AE of both timing and force were increased in both groups with an increase in the target velocity, and the values for ball game players in both instances were significantly smaller than they were for non-players. Discussion The CE of timing values indicated that a delay in the timing of peak force production compared to the arrival of the target was increased with increasing target velocity in both groups. The AE in timing values suggested that the coincident timing accuracy was reduced with increasing target velocity in both groups. In force production, the CE value indicated that the degree of greater gripping than target force (30 % MVC) was increased with increasing target velocity. Further, the result of the AE in force suggested that the force production accuracy decreased with increasing target velocity in both groups. However, these errors of force and timing were smaller in ball game players than in non-players. Therefore, the results of the present study suggest that the accuracy of force production and coincident timing during rapid gripping was higher in ball game players than it was in non-players.

### THE IMPACT OF TRAINING IN NATURAL HYPOXIA ON TOTAL HAEMOGLOBIN MASS IN MALE CYCLISTS

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**Introduction** Conventional altitude training may increase in tHb-mass although the reported results are inconclusive and, moreover, not much is known about the persistence of tHb-mass after descending from altitude. The aim of this study was thus to examine the impact of classical altitude training camp on tHb-mass and to evaluate its stability throughout the following 3 weeks at the sea level. **Material and Methods** Six male road cyclists (age: 20.0±2.23 years, height: 184±9 cm, body mass: 71.5±8.36 kg) participated in the study. All cyclists resided at 1920 m and trained at about 1600-2300 m above the sea level for 20 days. The tHb-mass was determined by optimised CO-rebreathing method. Haemoglobin concentration (Hb) and hematocrit (Ht) were measured and plasma volumes (PV) were computed. The concentrations erythropoietin (EPO) and hypoxia-inducible factor 1alpha (HIF-1alpha) were assayed in serum. All measurements were done at baseline, on the last day of training camp, as well as twice thereafter – in the 2nd and 4th weeks. Additionally, EPO and HIF-1alpha concentrations were measured twice during the training camp – in the first and second weeks. Changes in mean values of all those indices were expressed as differences vs. baseline values ( $\Delta\%$ ). All data were subjected to ANOVA with repeated measures followed by post-hoc LSD test, the level of  $p < 0.05$  being considered significant. **Results** Altitude training resulted in significant increases in tHb-mass and Hb concentrations, by 4.9% ( $p < 0.01$ ) and by 8.3% ( $p < 0.001$ ), respectively. After returning to the sea level, tHb-mass decreased slightly, but remained significantly elevated in the second week (by 2.9%;  $p < 0.05$ ) and 20-24 days post-camp (by 3.9%;  $p < 0.01$ ); Hb concentration decreased significantly in the fourth week after descending from altitude by 6% ( $p < 0.01$ ) with respect to the last day of the camp. Furthermore, significant increases in HIF-1alpha concentrations in the first ( $p < 0.01$ ) and in the second week of training camp ( $p < 0.05$ ) was noted; a nearly significant ( $p < 0.06$ ) increase in EPO concentrations was also observed but both HIF-1alpha and EPO concentrations decreased significantly ( $p < 0.05$ ) 20-24 days post-camp. There were no significant differences in PV, either during or after the training camp. **Conclusions** Training under natural hypoxia conditions brought about an activation of erythropoiesis that resulted in increased tHbmass. No significant changes in tHbmass were noted after descending from altitude; its level remained significantly higher during the 3 weeks post-camp. email: jadwiga.malczewska@insp.wa.wpl

### REPEATED SHORT-TERM EXPOSURES TO NORMOBARIC HYPOXIA DO NOT PREVENT ACUTE MOUNTAIN SICKNESS IN SUSCEPTIBLE INDIVIDUALS

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**Introduction** Ascents to high altitude are associated with the risk of acute mountain sickness (AMS) (Netzer et al., 2013). Pre-acclimatization by repeated short-term exposures to normobaric hypoxia (7 x 1 hour at 4500 m) has been shown to reduce the severity of AMS during a subsequent exposure to normobaric hypoxia (Wille et al., 2012). However, recently the effects of pre-acclimatization in normobaric hypoxia were put into question (Fulco et al. 2013). Therefore, the present study tested the effects of pre-acclimatization in normobaric hypoxia on the prevalence and severity of AMS during a subsequent exposure to real high altitude in persons susceptible to AMS. **Methods** Thirty-two healthy persons, susceptible to AMS, participated in this study. Participants were randomly assigned to the hypoxia group (HG) or the control group (CG) before the pre-acclimatization program (7 passive 1-hour sessions within 7 consecutive days). The HG was exposed to a simulated altitude of 4,500 m (FIO<sub>2</sub> 12.6%) whereas the CG breathed sham hypoxia (normoxic air, FIO<sub>2</sub> 20.9%) during the sessions. After finishing the pre-acclimatization program, participants were exposed to real high altitude (Mönchsjoehut, Switzerland, 3650 m) for 45 hours. AMS (Lake Louise score) and resting ventilation (MetaLyzor, Cortex, Germany) were assessed before ascending to high altitude (baseline values) and during the high-altitude exposure (AMS after 3, 6, 9, 21, 30, and 45 hours; ventilation after 21 hours). Overall AMS incidence was compared by Chi-square-tests and a two-way ANOVA for repeated measurements was applied for the severity of AMS and resting ventilation. **Results** Overall AMS incidence was 59 % in the HG and 67 % in the CG respectively and did not differ between groups ( $p = 0.65$ ). There were no differences in AMS severity between groups (ANOVA interaction  $p = 0.76$ ). Changes in resting ventilation from baseline to high altitude tended to be more pronounced in the HG compared to the CG ( $+2.0 \pm 2.5$  l/min vs.  $+0.3 \pm 2.3$  l/min;  $p = 0.06$ ). **Discussion** The applied pre-acclimatization program seems to have resulted in moderate ventilatory adaptation. However, these adaptations did not prevent AMS during an exposure to real high altitude in AMS susceptible individuals. Further studies should investigate if a higher dose of normobaric hypoxia effectively prevents AMS during after a rapid ascent to high altitude. **References** Fulco CS, Beidleman BA, Muza SR. (2013). *Exerc Sport Sci Rev*, 41, 55-63. Netzer N, Strohl K, Faulhaber M, Gatterer H, Burtcher M. (2013). *Travel Med*, 20, 247-255. Wille M, Gatterer H, Mairer K, Philippe M, Schwarzenbacher H, Faulhaber M, Burtcher M. (2012). *Scand J Med Sci Sports*, 22, e79-e85. Contact martin.faulhaber@uibk.ac.at



## THE EFFECTS OF ARM WARMERS ON THERMAL AND METABOLIC RESPONSES WHILE RUNNING IN A COLD ENVIRONMENT.

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**Introduction** Individuals who exercise outdoors (e.g., participate in soccer, rugby, marathons) in winter can expose themselves to cold conditions and cooling of the body may result. Cold exposure often produces detrimental effects on physiological responses and exercise performance. In recent marathons held in winter, many runners have worn arm warmers as a measure against the cold. Tight-fitting 100% polyester sleeves worn over the arm have been believed to prevent heat loss from the body to the surrounding environment and to provide thermal comfort. **Purpose** The purpose of this study was to investigate the effects of arm insulation on physiological responses during exercise in the cold. We hypothesized that arm insulation would suppress decreases in body temperature and improve cold strain during sustained exercise. **Methods** Seven healthy men (mean ( $\pm$  standard deviation) age,  $22.4 \pm 3.9$  years; height,  $170.6 \pm 6.5$  cm; mass,  $66.9 \pm 8.1$  kg;  $VO_{2max}$ ,  $52.3 \pm 4.79$  mL/kg/min) who were non-smokers and not currently taking medication participated in this study. Participants rested for 5 min and exercised on a treadmill at 70% $VO_{2max}$  intensity for 30 min wearing the arm warmer (ARM) or not (CON) at 5°C and 40% relative humidity. Head wind equal to running speed was blown on the participant during exercise. Trials were randomly assigned and balanced for order. **Results** Rectal temperature was significantly higher in ARM than in CON at 5 min ( $p < 0.05$ ). Mean weighted skin temperature was significantly higher in ARM than in CON from 15 to 30 min ( $p < 0.05$ ). Upper arm temperature was significantly higher in ARM than in CON from 15 to 30 min ( $p < 0.05$ ). Chest, thigh and calf temperatures as well as oxygen consumption and heart rate did not differ significantly between groups. Plasma lactate and plasma norepinephrine levels were significantly lower in ARM than in CON at 10 min ( $p < 0.05$ ). Thermal sensation was significantly higher in ARM than in CON at 0 min ( $p < 0.05$ ). Plasma glucose, plasma epinephrine, serum triglyceride and serum free fatty acid levels were not significantly different between conditions. **Discussion** The higher rectal temperature and thermal sensation and lower plasma norepinephrine levels indicate that the arm warmer suppressed heat loss during the early phase of exercise in the cold. In addition, attenuated sympathetic nerve activity might have suppressed plasma lactate levels by decreasing intermuscular glycogenolysis. **Conclusion** Arm warmers are effective against cold stress, particularly during the early phase of exercise.

## CHANGES IN CIRCULATING MICRORNA'S BETWEEN HIGH AND LOW RESPONDERS TO A 16-WK DIET AND EXERCISE WEIGHT LOSS INTERVENTION

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**Introduction** MicroRNAs (miRNAs) are small non-coding RNAs that regulate the expression of target mRNAs and proteins. Certain miRNAs can be released into the circulation (c-miRNAs) for transport to selected recipient cells and have been shown to be altered in response to acute exercise and chronic training (Flowers, Won & Fukuoka, 2015), as well as energy-restricted weight loss (Milagro et al., 2013) or surgery-induced weight loss (Ortega et al., 2013). The aim of this study was to determine the expression profile of selected c-miRNAs following a 16 week exercise and high dairy protein diet program in individuals who either lost a large (high responders; HiRes) versus a small (low responders; LoRes) amount of body mass (BM) post intervention. **Methods** From a data set of 89 male and female overweight/obese participants who completed the intervention (500 kcal energy restriction from diet [250 kcal] and exercise [250 kcal]), a subgroup of HiRes (>10% BM loss,  $-11.0 \pm 2.4$  kg,  $n=22$ ) and LoRes (<5%,  $-3.0 \pm 1.3$  kg,  $n=18$ ) were identified. RNA was extracted, quantified and reverse transcribed from fasted plasma samples collected pre and post intervention. Quantification of miRNA was performed on a customized 96-well miScript miRNA PCR Array (Qiagen). **Results** Loss of BM (8.0 kg) and fat mass (FM; 7.7 kg) was greater for HiRes than LoRes ( $P < 0.001$ ). Of the 13 c-miRNAs investigated, there was a higher baseline expression of miR-935 in LoRes compared HiRes ( $1.06 \pm 0.52$  vs  $0.72 \pm 0.35$ ;  $P=0.025$ , 95%CI: 0.044 – 0.633). The miR223 increased post intervention in HiRes only (Pre:  $0.88 \pm 0.89$  vs Post:  $1.67 \pm 1.48$ ;  $P=0.041$ ). There were no post-intervention changes in the other c-miRNA's measured in either groups. **Discussion** This is the first study to quantify the expression profile of selected c-miRNA's following a combined diet and exercise intervention to achieve BM loss. The higher baseline expression of miR-935 in LoRes supports previous findings from a diet-only intervention (Milagro et al., 2013) suggesting miR-935 may be an important baseline prognostic biomarker for assessing individual responsiveness to energy restricted dietary and exercise-induced weight loss. Further, the selective increase in miR-223 expression in HiRes suggests it may regulate putative downstream targets that positively influence weight loss with diet and exercise. **References** Flowers E, Won GY, Fukuoka Y. (2015). *Physiological Genomics*, 47(1), 1-11. Milagro FI, Miranda J, Portillo MP, Fernandez-Quintela A, Campión J, Martínez JA. (2013). *PloS One*, 8(1), e54319. Ortega FJ, Mercader JM, Catalán V, Moreno-Navarrete JM, Pueyo N, Sabater M, Fernández-Real JM. (2013). *Clinical Chemistry*, 59(5), 781-792. Email: Evelyn.parr@acu.edu.au

## TCD4+ LYMPHOCYTE ARE RELATED TO MUSCLE STRENGTH PARAMETERS IN HIV-1 POSITIVE ADOLESCENTS

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**Introduction:** Catabolism of muscle and loss of function are complications that can occur during the course of Human Immunodeficiency Virus-type 1 (HIV-1) infection and are commonly seen in a majority of adolescents with vertically transmitted HIV. The levels of CD4+ and CD8+ lymphocytes, reference markers for the treatment of vertically transmitted HIV-1, also decline as the disease progresses. Alterations of these reference markers may be associated with neuromuscular force parameters in sedentary adolescents that have potential as prognostic indicators for treatment administration. **Objective:** To investigate the relationship between maximal isometric muscular contraction force and levels of CD4+ and CD8+ lymphocytes in sedentary, vertically transmitted HIV-1 positive adolescents. **Methods:** The sample consisted of twenty adolescents (N= 9 males, 11 females, age 15-17 years) with vertically transmitted HIV-1. All patients were from the Institute of Infectious Diseases Emilio Ribas in São Paulo, Brazil undergoing HAART therapy and were randomly selected to participate in the study. The number of CD4+ and CD8+ cells was determined by flow cytometry using BD FACS Calibur Multitest Equipment, and Multiset-BD software. Viral load was determined using b-DNA methodology, on Siemens System Versatil 440 equipment. All analyses followed standard procedures approved by the Brazilian Ministry of Health. Muscular strength measurements were completed in the morning after blood collection along with weight and height measurements. Prior to starting, patients were familiarized with all testing procedures and strength exercises that were used for testing. After the warm up, maximum voluntary isometric muscular strength of the elbow flexors and knee extensors were assessed using an electric dynamometer (EMG210C, EMGLAB). Each patient made three attempts

with a rest interval of two minutes between trials. The highest isometric force and torque value were recorded and used for analyses. Results: Upper body force ( $r=0.70$ ,  $p=0.001$ ) and maximal torque ( $r=0.69$ ,  $p=0.001$ ) were significant correlated with CD4+ count. Similar observations between CD4+ count and lower body muscular force ( $r=0.62$ ,  $p=0.005$ ) and maximum torque ( $r=0.61$ ,  $p=0.007$ ) were also observed. CD8+ was not associated with any strength measures. Conclusion: CD4+ lymphocytes showed a strong correlation with force parameters in sedentary HIV-1 positive adolescents. Given that those individuals with higher TCD4+ counts showed a tendency towards manifesting higher muscle strength, this may be used as a predictor to indicate the level of physical capacity of patients and consequently help optimize treatment.

### SIX WEEKS OF HIGH-INTENSITY INTERVAL TRAINING REDUCES FAT MASS IN HEALTHY MALES

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**Introduction** High-intensity interval training (HIIT) has been shown to improve numerous health parameters including improvements in body composition (Gillen et al., 2013; Terada et al., 2013; Hazell et al., 2014) as well as glucose tolerance and insulin sensitivity (Babraj et al., 2009). Creatine supplementation has been shown to play a role in improving body composition (Gualano et al., 2010). This study aims to examine the effects of a 6-week HIIT programme, both independent of and combined with creatine supplementation, on body composition. **Methods** Twenty-eight male participants ( $23.2 \pm 5.8$  y;  $1.78 \pm 0.10$  m;  $78.7 \pm 14.4$  kg;  $24.8 \pm 2.7$  kg/m<sup>2</sup>) made a single fasted visit to the laboratory, pre and post a 6-week HIIT and/or supplementation intervention, where they underwent a whole body DXA scan (Hologic Discovery A, Hologic Inc., Bedford, MA, USA). HIIT involved repeated 30-second sprints (4 in weeks 1 & 2, 5 in weeks 3 & 4 and 6 in weeks 5 & 6) with resistance set at 7.5% body mass. Supplementation involved 5 g/day of either Creatine Monohydrate (CreaPure, AlzChem, Trostberg, Germany) or Placebo (Microcrystalline Cellulose, Blackburn Distributions Ltd, Lancashire, UK). A factorial analysis of covariance (SPSS v20, an IBM Company, New York, USA), with baseline values used as a covariate was used, with data combined when no interaction effects between HIIT and Creatine was observed. **Results** HIIT caused significant reductions in sub-total (-5.85 -v- 0.75%  $p<0.05$ ), and lower limb (-6.80 -v- -1.34%  $p<0.05$ ), fat mass with no observed effects on lean mass compared with non-exercising controls. Creatine supplementation had no effect on body composition. **Discussion** This study supports the use of short duration high intensity interval training as a potent method of reducing fat mass. This coupled with metabolic adaptations seen in glucose tolerance and insulin sensitivity (Babraj et al., 2009) means that HIIT has potential clinical adaptations, however the optimum intervention protocol needs to be established. The lack of adaptation due to creatine supplementation suggests that interventions of greater than six weeks in duration are needed in order to induce changes in body composition. **References** Babraj J., Volvaard N., Keast C., Guppy F., Cotterell, G., Timmons, J. (2009). *BMC Endocr Disord* 9: 3 Gillen J., Percival M., Ludzki A., Tarnopolsky M. Gibala M. (2013) *Obesity* 21(11): 2249-55 Gualano B., Artioli G., Poortmans J., Lancha Jr A. (2010) *Amion Acids* 38(1): 31-44 Hazell T., Hamilton C., Dylan Oliver T., Lemon P. (2014) *Appl Physiol Nutr Metab* 39: 1-7 Terada T., Friesen A., Chahal, B., Bell G., McCargar, L., Boule, N. (2013) *Diab Res Clin Pract* 99(2): 120-9 Contact: F.Guppy@brighton.ac.uk

## Psychology

### BRIEF GROUP INTERVENTIONS FOR YOUNG ATHLETES' PSYCHOLOGICAL FLEXIBILITY, RESILIENCE AND WELL-BEING

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**Introduction/aim** To evaluate effects of brief group interventions (Mindfulness Acceptance Commitment (MAC; Gardner & Moore, 2007) and traditional sport psychology (goal-setting, arousal regulation, imagery, self-talk and concentration skills) on young athletes' psychological flexibility, resilience and well-being. **Method** All participants were studying at a national sports program for athletes in upper secondary school (Mean age = 16.7 ( $\pm .9$ ); 91% men). A total of 42 athletes completed the MAC intervention and 14 athletes completed the traditional sport psychology intervention. One baseline (BL) and one post-intervention (PI) assessment was performed with The Satisfaction of Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985), the Acceptance and Action Scale (AAQ; Bond et al., 2011), the Mindfulness Attention Awareness Scale (MAAS; Brown & Ryan, 2003) and the Resilience Scale (RS; Wagnild, 2011). Both interventions included one seminar + one hour/week during five weeks with homework exercises. **Results** Significantly higher scores in the AAQ (Mean: BL = 13.12 ( $\pm 6.92$ ), PI = 15.22 ( $\pm 6.74$ ),  $t(40) = -2.79$ ,  $p<0.01$ ), lower scores in the MAAS (Mean: BL = 61.46 ( $\pm 12.86$ ), PI = 58.42 ( $\pm 11.99$ ),  $t(40) = 2.31$ ,  $p<0.03$ ) and RS (Mean: BL = 126.83 ( $\pm 17.49$ ), PI = 118.17 (23.76),  $t(41) = 2.86$ ,  $p<0.01$ ) but no significant differences in SWLS were displayed after the ACT intervention. The traditional sport psychology intervention showed no significant effects, which may also be a consequence of few participants in the sample. **Discussion** Results indicate positive effects of the brief group intervention of ACT on young athletes' psychological flexibility. Surprisingly, lower mindfulness and resilience scores were displayed which could indicate a true decrease but, considering methodological limitations with self-rate assessments, could also be a result of a higher awareness of thoughts and emotions among participants post- compared to pre-intervention. **References** Bond, F.W., et al., (2011). Preliminary psychometric properties of the Acceptance and Action Questionnaire-II: A revised measure of psychological flexibility and experiential avoidance. *Behavior Therapy*, 42, 676-688. Brown, K.W. & Ryan, R.M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, 84, 822-848. Diener, E., Emmons, R.A., Larsen, R.J., & Griffin, S. (1985). The Satisfaction With Life Scale. *Journal of Personality Assessment*, 49, 71-75. Gardner, F., & Moore, Z. (2007). *The psychology of enhancing human performance. The mindfulness-Acceptance-Commitment (MAC) approach*. New York: Springer Publishing Company. Wagnild, G.M. (2011). *The resilience scale user's guide*. The Resilience Center ([www.resiliencecenter.com](http://www.resiliencecenter.com)). Contact carolina.lundqvist@gih.se

### VALUES AND MOTIVATION IN HIGH PERFORMANCE ATHLETES

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1: Unitat d'Esport i Salut. Consell Català de l'Esport (Spain) 2: Unidad de Investigación de Psicología del Deporte. University of Valencia (Spain) **Introduction** Values has been considered as having an impact on motivation (Schwartz, 1994) and their relation to motivational processes would provide insight on how human functioning can be optimised (Parks & Guay, 2009). In the sport context, these relationships have received scant attention. Among the few papers on the subject, Balaguer and her colleagues have studied the association between personal values and motivational orientations and regulations in young amateur athletes and have analysed gender differ-

ences in values and motivation (Balaguer, Castillo, Quested & Duda, 2013). In this research, the aim was to replicate the study of Balaguer et al. with high performance athletes. Methods A total of 139 high level Spanish athletes from different sports (52 men and 87 women) ranging in age from 14 to 20 years ( $M = 15.7 \pm 1.12$ ), participated in this study. All participants practice sport five days a week ( $M = 5.35 \pm 0.66$ ), for over four hours per day ( $M = 3.78 \pm 1.04$ ). Participants completed a questionnaire package tapping the variables of interest. Results The results of the regression analysis showed that ego orientation was negatively predicted by benevolence ( $\beta = -.28, p < .01$ ) and positively by hedonism ( $\beta = .19, p < .05$ ). Intrinsic motivation was negatively related to achievement values ( $\beta = -.25, p < .05$ ). Finally, external regulation was positively predicted by power ( $\beta = .26, p < .01$ ). Multivariate analysis of variance for each variable of interest indicated statistically significant differences between gender on benevolence, power, task orientation, ego orientation, intrinsic motivation and external regulation. Follow-up univariate analyses showed that women scored higher than men on benevolence, task orientation and intrinsic motivation; whereas men scored higher than women on power, ego orientation and external regulation. Discussion Results of this study with elite athletes are similar to those obtained with young amateur athletes in the research of Balaguer et al. (2013). These findings suggest that value systems can impact the meaning of and reasons for engagement in sporting pursuits. References Balaguer, I, Castillo, I, Quested, E, Duda, JL (2013). Values and motivational processes in sport: An AGT and SDT perspective. In J. Whitehead, H. Telfer, J. Lambert (Eds.), *Values in Youth Sport and Physical Education* (pp. 119-133). London: Routledge. Parks, L, Guay, RP (2009). Personality, values, and motivation. *Pers Individ Differ*, 47, 675-684. Schwartz, SH (1994). Are there universal aspects in the structure of human values?. *J Soc Issues*, 50, 19-45. Contact Email: Isabel.Castillo@uv.es

### THE EFFECT OF GAME PERCEPTION ON PLAYERS' MULTIDIMENSIONAL PERFORMANCE WITH SPECIAL FOCUS OF TEAM IDENTIFICATION AND ENTITATIVITY MODERATING EFFECT

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Introduction: The factors having the biggest impact on athletes' performance have been under discussion for several years if not decades. One of the most recent approaches puts the emphasis first on whether the game is perceived as a threat or a challenge which is then said to affect the other aspects of performance. The most thorough examination of this have been presented by Jones, Meijen et al. (2009) in the Theory of Challenge and Threat States in Athletes. However, it hasn't given much attention to the role of intra- and intergroup relations among the team players. The aim of this study is therefore to examine the effect of game perception (threat vs. challenge) on players' multidimensional performance and how much do variables such as group identification and entitativity modify that effect. Methods: A questionnaire study was conducted in a repeated measures design with 2 conditions included – control (at practice) and experimental (before the game). We examined responses from 22 male elite volleyball players from Polish first and second division. Variables assessed: entitativity, overall and specific skills perception, team identification, perceived control, collective self-efficacy, attitude towards the outcome of the game, perception of the game (threat vs. challenge) and mood. Results: Perceiving upcoming game as a threat was followed by a significant decrease in optimism towards the outcome of the competition as well as a decrease in the overall competence perception (specific skills perception decrease only on a level of a tendency). An increase in the level of pessimism towards the outcome was also observed. However, perceiving the game as a challenge had no influence on mentioned variables. Nonetheless, a statistical tendency to report higher energetic arousal and perceive emotions as helpful for performance followed the "challenge approach". Further analysis of the possible moderations showed only one significant relation – the level of team identification moderated the impact of "challenge approach" on perceiving the emotions as helpful for performance. Conclusion/Discussion: The study didn't show many group related moderating effects. However, the results seem to suggest that different ways of perceiving the competition affect different aspects of performance related variables. While "threat approach" is connected with the lack of confidence about having the means to win, "challenge approach" seems to have an impact only on physiological and physical aspects of performance. Therefore, further research on those connections and a deeper analysis of group-related variables impact is a must. Selected references: Cerin, E. (2003). *J. of Applied Sport Psych.*, 15, 223-238. Hogg, M.A., Sherman, D.K., Dierselhuis, J., Maitner, A.T., Moffit, G. (2007). *J. Exper. Soc. Psych.*, 43(1), 135-142. Jones, M., Meijen, C., McCarthy, P.J., Sheffield, D. (2009). *Int. Rev. of Sport & Exercise Psych.*, 2 (2), 161-180. McMinn, J.G. (2003). Unpublished PhD dissertation, Fac. of Arts & Sciences, Uni. of Pittsburgh Contact: kguraj@psych.uw.edu.pl

### A QUALITATIVE EXAMINATION OF MENTAL SKILLS IN ELITE REFEREES

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Introduction Sports umpires, referees and their assistants are responsible for ensuring that the competitive efforts of athletes take place within the rules of the game, and that match results are obtained fairly. Referees must continuously endure physical pressure; they should, however, also be willing to psychologically endure various stressors. As the best performance cannot be expected from athletes and coaches who are under a great deal of stress, referees are sometimes unable to demonstrate proper performance (Reilly and Eregson, 2006). One key factor in referees working to their capabilities in regard to performance is use of appropriate mental skills. The purpose of this study, therefore, is to investigate the mental skills of elite referees, and to drive home the impact of mental skills on performance. Methods Eight elite referees, representing four different sports (soccer, basketball, baseball, and tennis), served as participants. At the time of the interview, the average age of the participating referees was 39.1 years, with a range of 32 to 48 years. These referees had arbitrated sporting events at a top level for 10 to 24 years, with a mean of 16.3 years of refereeing experience. An interview guide, comprised of a series of open-ended and guided questions, was developed for this investigation. Qualitative interviews were between 35 and 60 minutes long, and were transcribed, coded, and analysed by three experienced qualitative researchers. Results Participants were asked the general question, "What mental skills helped you to succeed as an elite referee?" One hundred sixty-one raw data responses resulted from the answers to this question. These raw data responses were content analysed; the three researchers discussed and came to a consensus on the grouping of the raw data responses, transforming them into meaningful subcategories and larger groupings. This procedure resulted in 22 subthemes that were grouped into 20 higher-order themes; these were then summarized with seven overall mental skills categories: 1) emotional control, 2) communication, 3) resolute attitude and look, 4) concentration, 5) confidence, 6) decisive thinking, and 7) motivation. Discussion After an extensive review of the literature, we found that Weinberg and Richardson (2002) identified a number of psychological characteristics that are true of highly successful referees. Furthermore, mental skills that were used to achieve an optimal psychological state were identified. The qualitative results collected from our participants paralleled these results exactly. The information gathered from this work also provides insight into how we can better create mental skills training program for this population. Reference Reilly, T. and W. Eregson, 2006 *Special populations: The Referee and Assistant Referee.*

### **TIME AND BALL MOVEMENT ANTICIPATION AND ITS RELATIONSHIP WITH THE AFFECTIVITY OF SOME ARTISTIC SKILL ACCORDING TO SPECIALIZATION IN VOLLEYBALL**

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The importance of the study lies in finding a relationship between time and ball movement anticipation as a mental ability with the affectivity of skill performance of some artistic skill according to players' specialization. Anticipation can be detected by using high accuracy programs that provide intensive data about the players any coach will need. The problem of the study lies in the lack of using psychological labs for measuring mental abilities including ball movement and time anticipation for volleyball players. These anticipation tests are considered very important in determining the time of response. Ball movement anticipation is also important in determining where the ball's path and to which player or position so as each player can benefit from it according to his specialization. The researcher used the descriptive method. The subjects were (40) elite Iraqi club players for volleyball specialization (setter, libero and spiker). The apparatuses used in the research were time and ball movement anticipation apparatuses as well as skill performance affectivity program analysis according to the players' specialization. The affectivity of play was detected through shooting (16) match for each team that is two matches for each team. Correlation relationships were used to identify the degree of correlation between tests. researcher recommended the following: Using these special tests to anticipate time and motion to measure skill performance of players according to their specializations. Using Vienna system to compare among players' specializations. Using the curriculum of the proposed training program and generalization it on all coaches to achieve better results.

### **FREQUENCY, INTENSITY AND DIRECTION OF ANXIETY AND ITS RELATIONSHIP TO GROUP COHESION IN A JUVENILE VOLLEYBALL TEAM**

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Introduction It is observed to be increasingly important group processes related to sports performance, among which stands out the group cohesion. The objective of this study was to analyze the relationship between the level of group cohesion and pre-competitive anxiety athletes of a volleyball team in the competitive situation. Methods The study included 12 volleyball athletes male, mean age  $16.33 \pm 0.65$  and practice time of  $1.29 \pm 0.89$ , one of the teams participating in the Final Phase of Paraná State School Games 2013. The Group Environment Questionnaire (GEQ) was validated for the Portuguese language, for evaluation of group cohesion level of the team. Already pre-competitive anxiety was assessed by Competitive State Anxiety Inventory (CSAI-2R). Results Significant correlations were found for the frequency ( $p = 0.02$   $r = 0.66$ ) and intensity ( $p = 0.04$   $r = 0.61$ ) anxiety only between the dimension of self-confidence and individual attraction dimension to the group-social (AI-S). Considering the direction of anxiety, it was observed that the somatic anxiety showed significant correlation of moderate intensity, with the integration of dimensions for the social group ( $p = 0.02$   $r = 0.67$ ) and individual attraction to the group -social ( $p = 0.03$  and  $r = 0.62$ ). Self-confidence, also correlated in a moderate way, with the integration of dimensions for the social group ( $p = 0.03$   $r = 0.61$ ) and individual attraction to the social group ( $p = 0.02$   $r = 0.67$ ). It was observed that the athletes experienced the symptoms of anxiety in a positive way and showed high levels of group cohesion, promoting their sport performance. Discussion The results corroborate the findings with amateur athletes of different individual and team sports (Fernandes et al., 2014), which also perceived the anxiety scales (cognitive, somatic and confidence) as facilitators of sports performance, suggesting a positive correlation between intensity and direction of anxiety (Lundqvist et al., 2011). Cohesion task-group reflects the degree to which group members work together to achieve common goals (Carron et al., 2002), which can be seen in the tactic of volleyball game, in which the actions for the construction of play depend on the joint efforts of the athletes. References Lundqvist C, Kenttä G, Raglin JS. (2011). Directional anxiety responses in elite and sub-elite young athletes: intensity of anxiety symptoms matters. *Scand J Med Sci Sports*, 21(6), 853–62. Fernandes Mg, Adriana S, Nunes N, Raposo Jv, Fernandes Hm. (2014). Effects of experience on the dimensions of intensity, direction and athletes 10(2), 81–9. Carron A, Colman M, Wheeler J, Stevens D. (2002). Cohesion and performance in sport: A meta analysis. *J Sport Exerc Psychol*. 24(2), 168–88. Contact joicemstefanello@gmail.com

### **THE RELATIONSHIP BETWEEN STRESS RESPONSE AND WEIGHT MANAGEMENT AMONG UNIVERSITY STUDENTS**

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Introduction Compared to males, more female youths practice weight management (Ikeda & Ikeda, 2004). A slim body has long been an objective for many female youths (Ministry of Health, Labor & Welfare, 2001). There are however associated risks relating to physical and mental health, especially if the methods of controlling one's weight are too severe. The aim of the present study was therefore to investigate the relationship between stress response and weight management among university students. Methods The participants were 411 university students (males: 169, females: 242). All participants completed the Stress Response Scale consisting of 7 inferiority factors; Depression, Anxiety, Anger, Emotional instability, Social withdrawal, Physical fatigue, and Autonomic nervous system (Ozeki, 1990), and the European Health and Behavior Survey (Wardle & Steptoe, 1991) in its Japanese version (Tsuda et al., 2005). Results The results of the t-test showed a significant gender difference of approximately 5% in the sub-totals for mental ( $t = 2.5$ ) and physical ( $t = 2.6$ ) stress response, and for their inferiority factors: Depression ( $t = 3.5$ ), Anger ( $t = 2.4$ ) and Physical fatigue ( $t = 3.4$ ). Scores pertaining to females were consistently higher than those pertaining to males. In the chi-square test, the proportion of females managing their weight (75.3%) was significantly higher than the proportion of males (42.9%). In the two-way layout ANOVA with general linear modeling, there was no discernible relationship between weight management and exercise. In terms of the main effects, the group managing their weight showed a higher stress score in the Social withdrawal and Physical fatigue categories, and the group doing exercise showed a lower stress score in the sub-total of mental stress and its inferiority factors of Depression and Social withdrawal. Discussion The results of the present study were similar to those of previous studies on the high probability of a high stress response among female youths practicing weight management (Ozeki, 1999; Ikeda & Ikeda, 2004). Moreover, weight management was found to relate to Social withdrawal as a symptom of mental stress and to Physical fatigue as a symptom of physical stress. However, weight management through exercise was shown to reduce mental stress. These results demonstrate that weight management through exercise is the most beneficial method for

the mental and physical wellbeing of youths. References Ikeda, T. and Ikeda, T. (2004). J Nishi-Kyushu University & Saga Junior College, 34, 135-139. Ministry of Health, Labor & Welfare (2001). National nutrition survey. Ozeki, Y. (1990). Bulletin of the graduate school of Kurume University, 1, 9-32. Tsuda, A., Nagatomi, K. and Tanaka, H. (2005). Jpn J Health Psychology, 18(2), 1-15. Wardle, J. and Steptoe, A. (1991). Social Science and Medicine, 33, 925-936. Contact: ikeda.tomo313@gmail.com

### ATTITUDES TOWARDS PHYSICAL ACTIVITY OF ELEMENTARY AGE CHILDREN AFTER AN 8 WEEK AFTER-SCHOOL PROGRAM

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**Introduction** Young children enjoy physical activity (PA) during play but often in today's society become increasingly sedentary as they age due to a variety of factors such as attitude toward PA. School settings have shown to be optimal environments to incorporate PA (Rickwood, 2013). This study examined if the environment of an after-school program was conducive to cause changes in attitudes towards PA. **Methods** The intervention consisted of an eight week after-school program in which 43 students (age=9.29±.67yrs) met three times per week for one hour to engage and self-regulate their activity level in various games and running activities aimed at increasing overall fitness with an emphasis on cardiovascular conditioning. Self-regulation and autonomy toward exercise has shown to be successful (Teixeira et al, 2012). A Subjective Exercise Experiences Scale (SEES) survey was also administered at the onset and culmination of the intervention (weeks 1 and 8) to assess positive attitudes, psychological distress and fatigue related to PA. Independent t-tests were used to analyze subscale outcomes pre vs. post intervention, male versus female, 3rd grade versus 4th grade and also individuals who ran laps at recess and those who did not. **Results** The responses for distress were significantly higher for girls than boys (17.42±4.68 vs 19.92±2.00 t=2.36, p=0.014). There was no significant difference in responses to the SEES for grade level (p>0.05) or recess lap participation (p>0.47). There was a non-significant increase in the fatigue (15.45±4.75 vs 16.53±4.60) and positive attitude (23.55±4.22 vs 25.24±2.91) subscales from pre to post of 6.94% and 7.23% respectively. **Discussion** At this level, there are many developmental differences between boys and girls (Kantsios, 2010). The subscale responses to distress indicated that male students showed a more favorable response to exercise than the females. In addition, there was no significant changes in any of the SEES subscales with the increase in PA. The lack of change in distress and fatigue subscales while significantly increasing PA over an eight week period may be an indication that the environment in the intervention was conducive to a positive experience for PA. **References** Allender S, Cowburn G, Foster C (2006). Health Educ Res (6) 826-835. Kantsios S (2010). Int Q Sport Sci (2) 10-17. Markland D, Emberto M, Tallon R (1997). Human Kinetics 19, 418-433. Rickwood G (2013). Can J Educ Admin P 143 Story M, Nanney M, Schwartz M (2009). Milbank Q 87(1) 71-100. Teixeira P, Cerraca E, Markland D, Silva M, Ryan R (2012). Int J Behav Nutr Phys Act (9)78.

### THE EFFECTS OF EIGHT WEEK AEROBIC EXERCISES ON MENTAL HEALTH AND SELF-ESTEEM OF TYPE 2 DIABETES MELLITUS

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**THE EFFECTS OF EIGHT WEEK AEROBIC EXERCISES ON MENTAL HEALTH AND SELF-ESTEEM OF TYPE 2 DIABETES MELLITUS** **Introduction** Mental health and physical health are very closely tied together, and each can exert a significant effect on the other (Cohen and Shamus, 2009). Mental health is one of the most important general public health and government policy in recent years (Health, 2011). Type 2 diabetes mellitus is a disease that has seriously endangered the health of many people. This study aimed at investigating the effects of 8 week aerobic exercise on mental health, including the aspects of physical symptoms, anxiety and insomnia, social functioning and depression and also self-esteem in men with type 2 diabetes mellitus. **Methods** This clinical trial study was performed on forty six male with type 2 diabetes mellitus selected and classified randomly into experimental (n=23) and a control group (n=23). GHQ-28 and Rosenberg test were used before and after intervention to assess general health and self-esteem. The experimental group performed aerobic exercise 45 minutes at 60-70 percent of heart rate three times a week for 8 weeks, while the control group did not do any special extra activity then. **Inferential statistical**, such as the t-test in the form of independent samples, the Mann-Whitney test and Cronbach's Coefficient Alpha, were used to determine the reliability of the measuring tools. Differences at p<0.05 were considered significant. **Results** Statistical analysis showed that aerobic exercise had significant effects on mental health (P=0.020), subscales of physical symptoms (P<0.001), depression (p=0.044). It had no significant effect on subscales related to social functioning (P=0.207) and anxiety and insomnia (P=0.078). The dependent T-test showed a significant increase in the average scores of self-esteem in the experimental group (P<0.001). **Discussion** According to the results, aerobic training had a significant effect on the mental health and self-esteem of diabetics. So the results are in line with the findings offered by (Madden, 2013). Generally, we can conclude that physical exercises can be mentally beneficial for both healthy and sick people. Aerobic exercise is considered as an effective strategy and approach for improve mental health and self-esteem of the people with type 2 diabetes mellitus. **References** Cohen G, Shamus E. (2009). Depressed, Low Self-Esteem: What can exercise do for you?. J of Allied Health Sciences and Practice, Vol. 7 No. 2. Health, Department of. (2011). No health without mental health: A cross-government mental health outcomes strategy for people of all ages HMSO, London. Madden KM. (2013). Evidence for the benefit of exercise therapy in patients with type 2 diabetes. Diabetes Metab Syndr Obes 6:233-239. srmg45@yahoo.com

### DOES PHYSICAL ACTIVITY CONTRIBUTE TO A DECREASE IN LONELINESS? A SYSTEMATIC REVIEW

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**Introduction** It is a common presumption that being physically active in groups can reduce loneliness by enhancing social contacts. With regard to social contacts, the magnitude of loneliness depends on qualitative (e.g., social support) rather than quantitative (e.g., number of social contacts) relationship characteristics (De Jong Gierveld et al., 2006). Thus, when regarding the physical activity (pa) context, we hypothesize that only positively characterized pa group relationships reduce loneliness. To our knowledge, this effect has not been evaluated systematically prior to this work. Therefore, this work aims at providing an overview of the existing research on the relationship of loneliness and pa. **Methods** A systematic literature search was conducted in the databases SportDiscus, PsycInfo, PsycArticles and Psyn-dex. The search term loneliness was combined with each of the search terms physical activity, exercise and sport. Non-peer-reviewed articles and publications in languages other than English were excluded. A total of 27 studies were included in the review. **Results** The majority of the 27 studies addressed adolescent or elderly samples. Nineteen studies were cross-sectional, four longitudinal (two exam-

ining the influence of pa on loneliness, two examining the influence of loneliness on pa) and four intervention studies (examining the influence of pa-interventions in a group setting on loneliness). Eleven cross-sectional studies found a direct, negative association between pa and loneliness. Two cross-sectional studies investigating indirect relationships found social support and social competence to mediate this association. The longitudinal studies found a negative influence of loneliness on pa, but no influence of pa on loneliness. However, each of the intervention studies found pa to reduce loneliness. One of these indicated that the decrease in loneliness was related to a positive change in social support by the other pa course participants. Discussion Overall, the studies imply a potential loneliness-reducing effect of pa in a group setting. However, this seems to be dependent on the quality of personal relationships in pa groups. Therefore, exercise instructors should, for example, consider creating a socially supportive climate in order to reduce loneliness. Studies further suggest that loneliness itself might lead to a reduced probability of engaging in pa. This could be attributed to low volitional control for initiating pa due to high stress, as loneliness is a stressful experience (McHugh & Lawlor, 2013). References De Jong Gierveld J, van Tilburg T, Dykstra PA (2006). In AL Vangelisti, D Perlman (Eds.), *The Cambridge handbook of personal relationships* (485–500). Cambridge, New York: Cambridge University Press. McHugh JE, Lawlor BA (2013). *Br J Health Psychol*, 18(3), 546–555. Contact f.pels@dshs-koeln.de

### COMPARISON OF EMOTIONAL INTELLIGENCE IN ATHLETES WITH DOPING HISTORY IN COMPARISON WITH GENERAL POPULATION

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Background: Regarding increasing and concerning worldwide trends of doping and lack of definite information about contributing factors in this era, this study was performed to determine the emotional intelligence in athletes with doping history in comparison with general population. Methods and materials: In this case-control study 30 subjects were enrolled including two groups of professional athletes with doping history and general population. In each group 15 subjects were present. The emotional intelligence was assessed by Bar-On Emotional Questionnaire. Results: The highest and lowest total scores in athletes group were 401 and 197 and in normal population group 410 and 243 were highest and lowest obtained scores and there was significant difference between total scores of two groups ( $P=0.001$ ), and also in some subscale items including stress tolerance, optimism, self-regard, impulse control, and assertiveness ( $P < 0.05$ ). Conclusions: Totally, according to the obtained results in this study, it may be concluded that there is significantly lower emotional intelligence in athletes with doping history in comparison with general population.

### COLLEGE FOOTBALL PLAYER'S COGNITIVE STRUCTURE OF TEAM TACTICS

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Introduction Team tactics is a very important factor in football games. It is also essential for coaches to grasp player's cognitive structure of team tactics. This study aims to develop a cognitive scale and demonstrate a structure of team tactics for college football players. Methods The study used a questionnaire answered by 310 male college Football players (age:  $19.9 \pm 1.2$  years, experience:  $12.4 \pm 2.9$  years). The questionnaire consisted of 44 questions about team tactics. The data collected was subjected to exploratory factor analysis, reliability analysis and confirmatory factor analysis by structural equation modeling. Results Five factors were extracted from the results using exploratory factor analysis. In the next exploratory factor analysis, the number of items of each factor is made equal, and each item was subordinated to each factor. The result also showed that each item had a factor loading amount over .40 and a simple structure. The Cronbach's  $\alpha$  of each factor was .76, .72, .67, .70 and .67, starting from factor 1. The fit coefficients by confirmatory factor analysis were sufficient (GFI=.945, CFI=.949, RMSEA=.049). All pass coefficients that observed variables from latent variables were significantly ( $p < .001$ ) and showed positive values more than a medium level (.48–.85). Discussion The factors extracted by exploratory factor analysis were called Understanding of the concept, Mastery, Importance, Difficulty and Emphasis of the result. We judged that the scale was sufficiently reliable, because the Cronbach's  $\alpha$  was over or near .70. The result of confirmatory factor analysis showed sufficient construct validity of the model, which comprised of 15 items of the five factors. College football player's cognitive structure of team tactics consisted five factors. The resulting scale had sufficient reliability and validity, and we provided suggestions about using this scale. References Uesaka, U. (2010) How Learning Strategy Use Transfers Across Different School Subjects: A Case Study on Promotion of Spontaneous Use of "Lesson Induction". *The Japanese Journal of Educational Psychology*, 58(1), 80-94. Contact koakutsu@nda.ac.jp

### GENERALIZED SELF-EFFICACY AND PHYSICAL ACTIVITY IN CHILDREN

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1: Department of Kinesiology, McMaster University (Hamilton, Canada), 2: Infant and Child Health (INCH) Lab, Department of Family Medicine, McMaster University (Hamilton, Canada), 3: Faculty of Applied Health Sciences, Brock University (St. Catherine, Canada) Introduction Our understanding of the long-term relationship between self-efficacy and physical activity is limited. The purpose of this study was to investigate the effect of self-efficacy on sedentary behaviours and physical activity patterns in school-aged children over time. Methods 2278 10-year-old children (1120 girls and 1158 boys) were followed up seven waves from 2005 to 2008. All children completed two questionnaires in each wave measuring self-efficacy (adequacy, predilection, and enjoyment) and physical activity patterns (sedentary behaviours (SED), free play (FRE) and organized activity (ORG)), respectively (Hay, 1992). Mixed-effects models were used to estimate changes in physical activity and self-efficacy within individuals over time, controlling for gender and motor ability. Results A significant time effect was found in FRE and ORG, indicating that FRE increased and ORG decreased over time. There were significant time by adequacy and time by predilection interactions for both FRE and ORG. Although children with high adequacy had higher FRE relative to other children, this effect diminished over time. Children with high predilection also had higher ORG, but the gaps between groups widened over time. Significant time by predilection and time by enjoyment interactions were found in SED. While SED was lower over time in children with high prediction, it was consistently higher in children with high enjoyment. The differences in SED between groups increased over time for both predilection and enjoyment. Discussion This study found that higher self-efficacy is related to greater participation in physical activity (Cairney, et al., 2005), and that the impact of predilection increases over time, which either facilitates the participation in free play, or buffers the decrease in organized play and the increase in sedentary behaviours. However, adequacy seems to be more important in explaining differences in young children. Interestingly, children with higher enjoyment were more to be sedentary over time, suggesting enjoyment of physical education does not translate into increased physical activity. Overall, this study highlighted the im-

portance of different components of self-efficacy on physical activity patterns. In addition, in order to improve children's physical health, interventions targeting on the enhancement of predilection may facilitate physical activity and reduce sedentary behaviours. References Cairney J, Hay JA, Fought BE, Wade TJ, Corna L, & Flouris A. (2005). *J Pediatr*, 147, 515-520. Hay JA. (1992). *Clin J Sport Med*, 2, 92-201. Contact li427@mcmaster.ca

### SWEDISH SWIMMERS' PERCEPTION OF PARENTAL INVOLVEMENT

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**Introduction** Parents play a critical role in children's sport involvement and throughout their sporting lives. Parental level of involvement can influence positively or negatively their children sport participation. Therefore, it is essential to explore the young swimming athletes' satisfaction in relation to parental level of involvement in their sport. The aim of this study was to investigate the style and the influence of perceived parental involvement on enjoyment and competitive anxiety in young Swedish swimmers. **Methods** Perceived parental involvement using the Parental Involvement in Sport Questionnaire (Wuerth et al., 2004), enjoyment (a questionnaire with 3 items that assess enjoyment in swimming) and competitive anxiety, SAS-2 (Smith et al., 2006) were assessed in 104 (61 female & male 43) Swedish swimmers, aged 9-18 years old (Mean age 13.7, SD 2.5). All participants were members of a swimming club at various competitive levels, spending an average of 10.5 months training for swimming per year. **Results** The athletes were satisfied with their parents' directive behavior and praise/understanding, but were slightly dissatisfied with their parents' level of active involvement and pressure. The negative discrepancy scores in active involvement and pressure revealed that athletes desire slightly more active involvement and pressure from their parents. A positive correlation was also found between perceived parental pressure and directive behavior. But, no correlations were found between athletes' perceived parental involvement and enjoyment or competitive anxiety. **Discussion** The young swimmers showed that they enjoyed their sport and were free of competitive anxiety in relation to their parents' involvement. Enjoyment can be decline when parents over-involved to their kids sport participation and young athletes have reported over-involved parents as a source of stress (Reeves et al., 2009) and most importantly, on contributing to kids burning out or dropping out of sport (Goodger et al., 2007). On the whole, young Swedish swimmers were satisfied with their parents' level of involvement in their sports, indicating the moderate and caring nature of Swedish parents in relation to the sport of swimming. **References** Goodger K, Gorely T, Lavalley D, Harwood C. (2007). *The Sport Psychologist*, 21, 127-151. Reeves, C. W, Nicholls A. R, McKenna J. (2009). *Journal of Applied Sport Psychology*, 21, 31-48. Smith, R E, Smoll, F L, Cumming, S P, & Grossbard, J R. (2006). Measurement of multidimensional sport performance trait anxiety in children and adults: The Sport Anxiety Scale-2. *Journal of Sport & Exercise Psychology*, 28, 479-501 Wuerth, S., Lee, M. J., & Alfermann, D. (2004). Parental involvement and athlete's career in youth sport. *Psychology of Sport and Exercise*, 5, 21-33. Contact anastasios.rodias@aspetar.com

### THE SUSTAINABILITY OF ACHIEVEMENT MOTIVATION IN YOUTH SPORT

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**Introduction** Participation in organized youth sport could be one context for identity development. For some athletes this could be one part in a multifaceted identity but for others (e.g. young high level athletes) the social organization of high-performance sports could cause burnout in athletes due to a lack of control and identity constrictions (Coakley, 1992). One social organization of high performance youth sport that has since mid-90's in Sweden grown in population is elementary sports schools. Further down the ages the demonstration of high competence and emphasis placed on sporting achievement could be essential and such pressure and/or expectations needs further investigation. The aim of this study is to examine the relationship among achievement goals, perceived competence and possible burnout components in (elite) adolescent-age athletes over time. **Methods** A longitudinal design based on three cohorts and on a convenience sample with youth athletes, age 13-14, from various team and individual sports, attending a sports school and regular elementary schools. The athletes will during a one year follow up respond to a number of questionnaires assessing achievement motivation and affective responses in youth sport. One cohort contains youth athletes who were selected to go to an elementary sports school in south of Sweden. The second cohort contains youth athletes who applied to that special elementary sports school but weren't selected. The third cohort contains youth athletes from an elementary school in a district that, by 40 socio-economical variables, could act as a "mini-town" regarding the town where the sports elementary school is located. **Structural equation modeling procedures** will be employed to evaluate the hypotheses. **Results** While the study is in the initial stage results have not yet emerged. However, some preliminary findings regarding the study will be presented and discussed during the conference. **Discussion** Results will be analyzed and discussed according to the purpose and the theoretical framework based on achievement goal theory in sport originated from Nicholls' (1989) two conceptions of ability (task and ego), Coakley's (1992) view on identity development in (elite) sport, and the multidimensional definition of athlete burnout (Raedeke & Smith, 2009). **References** Coakley, J. (1992). Burnout among adolescent athletes: a personal failure or social problem? *Sociology of Sport Journal*, 9, 271-285. Nicholls, J. (1989). *The competitive ethos and democratic education*. Cambridge, MA: Harvard University Press. Raedeke, T. D., & Smith, A. L. (2009). *The athlete burnout questionnaire manual*. Morgantown: West Virginia University: Fitness Information Technology. Contact joakim.ingrell@mah.se

### PERCEIVED EXERCISE BENEFITS FROM DIFFERENT AGE POPULATIONS

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**Introduction** Exercise participation nowadays has become people's regular habit in daily life. When doing exercise, most of the participants would gain psychological and physiological benefits such as a sense of well-being. Previous studies have emphasized that exercise in leisure time can play a significant part in enhancing the quality of life (Iso-Ahola, 1997). However, few studies have compared the differences in perceived exercise benefits among different age groups because different age populations might have different demands towards exercise. **Methods** Three participants representing different age populations, including a college student, a white collar, and a retired person, were recruited. Semi-structured interviews were conducted to collect data. **Results** The results found that all the three participants revealed a sense of well-being and social relationships were the best benefits of leisure-time exercise. Further, for the college student, exercise could meet the needs of seeking fun. For the white collar, participation in physical exercise was beneficial to mental and physical relaxation. For the retired person, physical and mental health was the first concern to engage in exercise. **Discussion** The findings indicated that different age groups would have different expected benefits they might want to obtain from physical exercise. For

different populations, exercise experience is particularly important for supporting well-being and building a meaningful life. Similar to previous research, participating in physical exercise can be helpful for an individual to gain benefits including the experience of happiness, positive emotion, and the development of one's full potential (Carruthers & Hood, 2007). Finally, professionals in exercise promotion are suggested to design different exercise programs that meet various demands of different age populations. Reference Battaglia, C., di Cagno, A., Fiorilli, G., Giombini, A., Borrione, P., Baralla, F., Marchetti, M., Pigozzi, F. (2014). *Crim Behav Ment Health*. doi: 10.1002/cbm.1922 Bloodworth, A., McNamee, M. (2007). *Health Care Analysis*. Vol. 15 Issue 2, 107-121 Maltby, J., Day, L. (2001). *Journal of Psychology*. Vol. 135 Issue 6, 651-660 Contact craigchen7889@gmail.com

### **RELATIONSHIPS AMONG PERSONALITY TRAITS, COPING STRATEGIES, AND CAREER BARRIERS OF COLLEGE STUDENT-ATHLETES**

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**Introduction** College student-athletes are expected to invest in the athlete and student role identities simultaneously. However, combining these two pursuits may limit their exploration of out-sport career options. Previous studies have reported that neurotic personality related to a negative perspective toward the life after retirement, while conscientious personality related to aspirational reasons for retirement (Robinson, Demetre, & Corney, 2010). Besides, coping strategies which can help individuals match the transition demands and individuals' resources are viewed as a key factor for successful transition (Stambulova, 2003). Little literature has previously linked the relationships between personality, coping strategies, and out-sport career barriers of college student-athletes. **Methods** This study recruited 356 junior and senior college student-athletes (224 males, 132 females, age = 21.21 years) to investigate the relationships between personality, coping strategies, and career barriers. Participants completed the Mini-Markers (a brief version of big-five markers), Career Coping Strategies Inventory, and Student-Athlete Career Situation Inventory-Career Barrier subscale. Multiple regression was conducted to examine the predictive effects of five personality sets and coping strategies on perceived barriers toward out-sport career explorations in college student-athletes. **Results** The multiple regression indicated that personality sets and coping strategies could totally accounted for 14.30% of the variance of career barriers ( $F(9,346) = 6.43, p < .05$ ). Particularly, emotional stability ( $\beta = -.18$ ) negatively predicted career barriers, whereas negative-emotional coping strategy ( $\beta = .26$ ) positively predicted career barriers. **Discussion** Consistent with previous research (Savickas, Briddick, & Watkins, 2002), the finding suggests that student-athletes who are low on emotional stability are more likely to perceive higher career barriers due to fewer career exploration behaviors. Those student-athletes who always deal with career difficulties using negative strategies, such as anger and avoidance, are more likely to face career barriers. This study supports the important relationships among personality, coping strategies and career barriers, indicating a close association between personal characteristics and career exploration behaviors in college athletes. Parents, coaches and guidance counselors might facilitate the career development of student-athletes by encouraging emotional stability and less usage of negative coping strategies, which could impact career-related behaviors, such as thinking about seeking knowledge and exploring career options. **References** Robinson OC, Demetre JD, Corney R. (2010). *Pers Individ Differ*, 48(7), 792-797. Savickas ML, Briddick WC, Watkins CE. (2002). *J Career Assess*, 10(1), 24-41. Stambulova N. (2003). *SIPF Yearbook 2003*, 97-109. Örebro University Press, Örebro.

### **SPORT ADDICTION AMONG HUNGARIAN UNIVERSITY STUDENTS**

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**Introduction** Recent decades saw thousands of research prove that the regular sport activity with adequate intensity and amount significantly contributes to maintaining one's health, while inactivity and the lack of fitness might fundamentally make one unhealthy. According to researchers, sport activities with sufficient quality and amount have a positive effect on the physical and mental health of adults as well as children and adolescents. When it comes to maintaining fitness and health, physical activity is the key factor along with dieting and nutrition. Nevertheless, sport can show that taking it too far may cause problems. **Method** Presently there are only few research on compulsive physical training and exercise addiction. These research mainly focus on running, aerobic sports and body building; only few deal with triathlon, dancing, weight lifting and other sports. For our study we looked for questionnaires that examine exercise addiction in general, define the psychic background, assess the ratio of physical activity, and do not concern any given kind of sport or form of motion. We used two questionnaires that met the criteria: Hausenblas and Downs' 21-item questionnaire, the Exercise Dependence, that uses the 7 scales consistent with the DSM-IV criteria: Tolerance; Withdrawal; Intention Effect (exercise is often taken in larger amounts or over a longer period than was intended); Lack of Control; Time (a great deal of time is spent in activities necessary to obtain exercise); Reductions in Other Activities (social, occupational or recreational activities are reduced); Continuance (exercise is continued despite knowledge of having a persistent or recurrent physical or psychological problem) The other questionnaire used is the Exercise Addiction Inventory, a short but very reliable and valid fill-out form. **Results** Surprisingly, the results gained by Griffiths and his peers showed that 3 % of the interviewees were addicted to exercising. Our study showed that 7,4 % of university students are highly, while 63 % are moderately addicted to physical exercise. According to international research, exercise dependence is more likely to manifest for men. Domestically, 4,9 % of men and 8,9 % of women are addicted in this regard. The detailed results of the 270-subject pool will be presented in the sports science conference. **References** Demetrovics Zsolt & Kurimay T (2008) - *Testedzsfüggőség: a sportolás mint addikció*, *Psychiatria Hungarica*, 23(2), 129-141. Griffiths, M. D.; Szabó, A. & Terry, A. 2005. The exercise addiction inventory: a quick and easy screening tool for health practitioners. *British Journal of Sports Medicine*, 39(6), e30. Hausenblas, H. A. & Downs, D. S. 2002b. How much is too much? The development and validation of the exercise dependence scale. *Psychology of Health*, 387-404. Piko B. F. & Keresztes N. 2006. Physical activity, psychosocial health, and life goals among youth. *Journal of Community Health*, 136-145. Contact geosits.beatrix@mnsk.ny.mhu

### **THE PERFORMANCE OF MULTIPLE OBJECTS TRACKING OF BASEBALL ATHLETES IS BETTER THAN PEERS IN DIFFERENT OBJECT MOVING**

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**Introduction** Attentively tracking multiple targets plays an important role for baseball athletes. Taking the outfielder as an example to avoid missing a flying ball, the experienced outfielder has to attentively track the ball, teammates and the base runner at the same time with the higher tracking accuracy. The present study was to investigate whether the baseball athletes have better performances of simul-



taneously tracking multiple objects than the peers. Method Thirty-nine elite collegiate baseball athletes ( $23.13 \pm 2.7$  y/o) and 39 undergraduate students ( $19.97 \pm 1.06$  y/o) were recruited. The multiple object tracking (MOT) task (Pylyshyn & Storm, 1988) was used to measure their ability of tracking multiple objects. In this task, participants were asked to simultaneously track three of eight objects, which independently and randomly wander about the screen for 4-5 seconds. In the end of each trial, participants reported which three objects were targets and the proportion of correct (%) was collected. If missing any target, the trial was marked as an error trial. Four different object-moving speeds (0.3, 0.6, 0.9, 1.2 deg/s) were manipulated in the study, and each speed conditions have 20 trials. To investigate the tracking performances between the baseball athletes and peers, a mixed designed repeated-measures ANOVA was conducted with speed as the within-subject independent variables and group as the between-subject independent variables. Result The proportion of correct for baseball athletes was significantly higher than their peers,  $F(1,76) = 4.69$ ,  $p = 0.033$ , and the main effect of speed was significant in proportion of correct,  $F(3,228) = 804.631$ ,  $p < 0.001$ . However, the interaction between groups and speeds was not significantly difference,  $F(3,228) = 0.036$ ,  $p = 0.991$ . Conclusion The result revealed that baseball athletes have a better performance of tracking multiple objects in most speed conditions than peers. This finding might provide the coach a useful information to improve the performance of baseball athletes or to select the potential elite baseball athletes. References: Pylyshyn Z, Storm R. (1988). *Spatial Vision*, 3(3), 179-197.

### **A COMPARATIVE STUDY OF THE IMPACT OF INDIVIDUAL AND GROUP SPORT ACTIVITIES ON THE MENTAL HEALTH OF CHAOXIAN NATIONALITY COLLEGE STUDENTS**

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Introduction Utilizing Mood Scale (BFS), this paper investigates the psychological impacts of selected individual and group sport activities among Chaoxian nationality college students, with a focus on the "instant" effect. The analysis provides theoretical support, methodological guidance, and new evidence for improving the mental health of Chaoxian nationality college students – and to a wider extent of ethnic minority students in general – through physical activities. Methods Based on an extensive literature review, the author designed and carried out an experiment among a sample of 135 Chaoxian nationality college students, utilizing Mood Scale (BFS) to measure psychological effects of individual and group sport activities. Examples of individual sport activities in this study include martial arts, aerobics, yoga, rope skipping, skating, and taekwondo. Examples of group activities include football, basketball, and volleyball. Data collected from the experiment was processed and analyzed by using statistical methods including T-test and covariance analysis. Results Results show that physical activities have positive effect on the mood status of Chaoxian nationality students. To be specific, individual sport activities have certain effect on the whole and relatively significant effect on female students; Group sport activities have negative effect on male students but positive effect on female students; Different sport activities have different psychological effects on college students of Chaoxian nationality. Discussion This paper is a primary attempt to study the differentiated effects of individual and group sport activities on the mental health of ethnic minority college students in China. Though its findings are exploratory in nature, the analysis further confirms the conclusion drawn from previous research: physical activities do influence mental health (e.g., Hou, 2012; Huang, 1997; Huang et al., 1995). If expanding the sample quantitatively and spatially in this study, it is very likely to attain more compelling evidence on the differentiated psychological effects of different physical activities among ethnic minority college students, providing theoretical foundation for China's national physical fitness program. References Hou H. (2012). The impact of different types of activities on mood status of Tujia nationality college students. *Journal of Shenyang Sport University*, 31 (5), 64-67. Huang Z. (1997). The impact of different types and intensities of activities on the mood of male college students. Wuhan Sport University (master thesis). Huang Z, Si G, Li Y. (1995). Mood benefits of exercise types and athletic sport activities. *Journal of Shanghai University of Sport*. 19 (4), 39-44. Contact hhsheng7602@126.com

### **THE RELATIONSHIP BETWEEN MOOD STATE AND ARTISTIC GYMNASTICS COMPETITION RESULTS**

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1Hungarian University of Physical Education, Budapest, 2University of Sunderland, UK Introduction A substantial number of investigations have highlighted that emotion is an inherent part of the competitive experience and influences performance (Beedie et al., 2000; Scott et al., 2002; van Wijk, 2011). The aim of this study was to examine the relationship between pre-competition mood state and gymnastics competition performance. Methods The Brunel Mood Scale (BRUMS) (Terry, Lane, Lane and Keohane, 1999; Terry, Lane and Fogarty, 2003) was filled out by 119 Hungarian gymnasts in 2013. Participants ranged in ability from international ( $n=20$ ), elite ( $n=43$ ) to second class ( $n=53$ ). Performance was determined based on the gymnastics competition score, and the final position. Results Of the investigated psychological factors, anger ( $r=0.231$ ,  $p=0.013$ ) tension ( $r=0.187$ ,  $p=0.045$ ) fatigue ( $r=0.258$ ,  $p=0.005$ ) were associated with the achieved result in the main event. Significant differences were found in the anger factor between groups. The international group showed significantly higher anger by the Post Hoc test. Discussion According to Pieter et al. (2006) athletes who have higher tension and anger before competition demonstrate decreased performance. In our study significant correlations were found between anger, fatigue and performance. According to Lane's (2002) findings, pre-competition anger and tension, on one hand, usually decrease individual performance. Higher achievement expectation of the international group results in higher levels of anger as opposed to the second class group that is related to the enhanced arousal requirement in elite performers. References Beedie CJ, Terry PC, Lane AM. (2000). *J Appl Sport Psychol*. 12 (1), 49-68. Scott VB Jr, Siles K, Raines D, Koth A. (2002). *N Am J Psychol*. 4, 457-468. Van Wijk CH. (2011). *S Afr J Psychiatry*. 17 (2), 44-54. Terry PC., Lane AM., Lane HJ. and Keohane L.(1999). *J Sports Sci*. 17, 861-872. Terry PC, Lane AM, Fogarty G.J. (2003). *Psychol Sport Exercise*. 4, 125-139. Pieter W, Wong RSK, Ampong C. (2006). *Acta Kines. Univ. Tart.* 11, 64-72. Lane AM. (2001). *J Sci Med Sport*. 4, 235-249. Contact boldorka88@gmail.com

### **ACL REHABILITATION: HOW TO SUPPORT HIGH MOTIVATION IN FOOTBALL PLAYERS AFTER INJURY AND SURGERY**

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Introduction Rehabilitation and full sport recovery after Anterior Cruciate Ligament (ACL) injury and reconstructive surgery need perseverance and willpower. The difficulties normally experienced by patients after injury can be overcome with high motivation during the recovery period (1, 2). The aim of this study was to explore which motivational factors were linked to a good compliance of a rehabilitation path, in order to better understand how professionals could support patients in coping with difficulties. Methods Five male football players

(aged 13 to 38 years) ranging from recreational to competitive athletes, previously undergone ACL surgical reconstruction followed by knee rehabilitation were recruited for this qualitative study. We conducted semi-structured interviews, specifically focusing on: 1) relationship with football 2) the injury 3) the recovery process with particular attention to surgery and rehabilitation. The interviews were conducted by a psychologist in the Rehabilitation Centre Isokinetic of Milan, in the winter months of 2014-15. We were interested in understanding their decision to opt for surgery, what information they had, what were their expectations. Moreover, we wanted to know how the rehabilitation period was. We applied a semi projective tool (fill in a graphic line that represents their feeling in the main steps of the path, starting from before the injury and arriving to the present). Results The injury was a different experience for the patients, in some cases it was described as a trauma, in other cases they did not appreciate its severity. They were quite worried about undergoing rehabilitation post- the surgery but their will to return to play football was the main helping factor. Finally, the football players reported this experience (the injury and the care process) as a very formative moment of their life which also helped with their self-esteem. Conclusion The interviews clearly show the importance of understanding the patient, his experience, his targets and his needs in order to provide better support during the rehabilitation process and achieve full recovery. A motivational speech before starting the rehabilitation process could be useful to better know the patient and his needs. References 1. Langford JL, Webster KE, Feller JA. A prospective longitudinal study to assess psychological changes following anterior cruciate ligament reconstruction surgery. *Br J Sports Med* 2009; 43: 377-378 2. Podlog L, Eklund RC. The psychological aspects of a return to sport following serious injury: A review of the literature from a self-determination perspective. *Psychology Sport Exerc* 2007; 8: 535-566

## THE RELATIONSHIP BETWEEN THE LEADERSHIP AND SELF-CONFIDENCE QUALITIES THE STUDENTS OF SPORT MANAGEMENT

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The relationship between the leadership and self-confidence qualities of the students of sport management. In order to examine on the leadership qualities, the sport with leadership scale, which had been improved by Chelladurai and Saleh in 1980, has been used. This scale has been adapted into Turkish by Toros and Tiryaki in 2011 and improved and validity and reliability tests have been carried out. The scale consist of five lowest stage. There are 40 clauses in the scale in total. In order to examine on the self-esteem qualities, the self-confidence scale, which had been improved by Coopersmith in 1967, has been used. This scale has been adapted into Turkish by Akin in 2007 and improved and validity and reliability tests have been carried out. The scale consist of two lowest stage. There are 33 clauses in the scale in total. Furthermore, face-to-face questionnaire method has been used and 189 students studying in different branches have been interviewed. After the questionnaires have been examined, the default ones were eliminated and 184 questionnaires have been subject to the analysis. Out of 184 students, 75 were female and 109 were male students. The reliability of the question prepared in accordance with the Likert scale, have been scaled with the Cronbach Alpha reliability scale. According to the analysis, the Cronbach Alpha rate has been found as 0,97 This rate is highly reliable. The leadership and self- confidence qualities scales of the students of sport management has been applied and in the light of the obtained data, the results have been evaluated and it has been determined that there is a significant relation between the lowest stages of leadership qualities and self- confidence qualities. The pearson correlation factor between democratic behavior low stage (,611), authoritarian behavior low stage (,029), social support low stage (,745), positive feedback low stage (,594), education and training low stage (,728) and inner self confidence low stage calculated. The pearson correlation factor between democratic behavior low stage (,633), authoritarian behavior low stage (,009), social support low stage (,741), positive feedback low stage (,616), education and training low stage (,703) and external self confidence low stage calculated.

## Rehabilitation and Physiotherapy

### DIFFERENCES IN KINESIOPHOBIA FOLLOWING TWO WEEK OF HOSPITAL-BASED CARDIAC REHABILITATION PROGRAM IN PATIENTS WITH CARDIOVASCULAR DISEASES

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Differences in kinesiophobia following two week of hospital-based cardiac rehabilitation program in patients with cardiovascular diseases Introduction Kinesiophobia is defined as irrational, weakening and devastating fear of movement stemming from the belief of fragility and susceptibility to injury (Kori et al. 1990). The key element of cardiac rehabilitation is the sufficient level of patient's physical activity – the element of Ideal Cardiovascular Health (Donald et al., 2010). Knowledge of psychological barriers in taking physical activity by patients and it's changes during cardiac rehabilitation are required to set the right education in prevention the cardiovascular diseases. Methods The study involved 39 people with cardiovascular diseases (23 female, 15 male, mean age 56.84 ± 7.89 years) participants of cardiac rehabilitation program. The program of rehabilitation include the physical exercises on the ergometers and health education episodes. The level of kinesiophobia at males and females was assessed twice, at the beginning and at the end of second week of rehabilitation program. A Polish version of Kinesiophobia Causes Scale questionnaire (Knapik et al 2012) was used. The scores of kinesiophobia were compared using the T-Student. The statistical significance was assumed at the level of p≤0.05. Results After two week of rehabilitation program, females achieved significant lower scores in all factors of kinesiophobia except morphological parameters where score was lower and the strength of biological drives where score was higher but the differences in those factors wasn't significant. Significant higher scores females achieved in the level of self – acceptance (p=0,016) and self – assessment of motor abilities (p=0,033). Males achieved significant lower scores in almost half of the factors of kinesiophobia: the level of energy resources (p=0,026), mood (p=0,011), susceptibility to social influence (p=0,021), biological domain (p=0,026) and general index of kinesiophobia (p=0,014). Only one factor have higher score , the level of biological drives but the difference wasn't significant. Discussion This study underline the differences in kinesiophobia between males and females at the beginning and at the end of cardiac rehabilitation program. Participation in physical exercises connected with educational episodes during cardiac rehabilitation program are enough factors to reduce most scores of kinesiophobia factors but the women are more sensitive on those influences than men. That suggest the rehabilitation program should be more individualized what is highlighted in The European Guidelines for prevention the cardiovascular diseases References Kori SH et al (1990) Pain Management, 3, 35-43 Donald M et al (2010) Circulation, 121, 586-613 Knapik A et al (2012) Med. Review of University In Rzeszow, 3, 277-287 European Association for Cardiovascular Prevention and Rehabilitation (2012) Polish Cardiology, 70, supl. I, S1-S100 Contact mbrdak@awf.poznan.pl

## EFFECTIVENESS OF TRAINING SQUAT IN THE NEUTRAL SPINE IN TREKKERS HAVING ANTERIOR PELVIC TILT AND KNEE PAIN

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Background Knee pain is a very common sight among trekkers, increased with walking downhill. Walking downhill has shown to exaggerate the anterior pelvic tilt, therefore, the aim of the study was to analyze the effectiveness of training squat pattern in the neutral zone of spine and hypothesize whether it will be effective in the management of knee pain in the trekking group. **METHODOLOGY** 19 subjects were screened and selected for the study through purposive sampling. The subjects were taught to maintain the neutral spine. Within the neutral spine they were asked to draw in the lower portion of the belly. The subjects were asked to lower themselves into the squat position maintaining the neutral spine and their abdominal muscle contraction. They were asked to contract their gluteal muscles consciously (30%-40% of their total strength) and raise themselves up in the starting position. Breathing cues were also given, subject inhales while lowering into a squat and exhales to lift himself up. Once the subjects mastered the correct squat pattern they were progressed into other squat patterns over a period of 3 months. Results: Paired t test was performed to statistically evaluate the overall change in the pain symptom. The p value at the end of the test showed  $p < 0.05$ , thus proving the test significant. Paired t test was performed to statistically evaluate the overall change in the movement pattern. The p value at the end of the test showed  $p < 0.05$ , thus proving the test significant. Discussion Trekkers have vague knee pain with no or minimal radiological changes. The purpose of this study was to analyze the effectiveness movement pattern correction (anterior pelvic tilt- neutral spine) in the squatting activity and its effect on the knee pain. The study demonstrated that there is a significant difference in the pain and functional movement. This may have been the result because, it's not activity but it's the lack of mobility and stability that gives rise to a problem. Repeated functional activities on a faulty base can cause overuse, compensation, postural changes and musculoskeletal imbalances. If left unchecked, symptoms of pain and inflammation develop. The best way to avoid accumulation of problems is to impose balancing and contrasting activities to counteract the effect of high volume unnatural patterning. References Veerle K. Stevens, Electromyographic activity of trunk and hip muscles during stabilization exercises in four-point kneeling in healthy volunteers. 2007 May; 16(5): 711-718. Okada, Tomoko; Relationship Between Core Stability, Functional Movement, and Performance. Jan 2011 - Vol 25 - Issue 1 - pp 252-261. Manohar M Panjabi, The Stabilizing System of the Spine, Part II. Neutral Zone and Instability Hypothesis, Vol 5 No.4 Aug 1992. Courtenay Schurman, The Outdoor Athlete, Jan 2009. Gray Cook, Dr. Burton, Movement. Thomas W. , Anatomy Trains, 2014. Phil Page, Frank, Assessment and Treatment of Muscle Imbalance, Janda Approach

## ACUTE CELL SWELLING IN GASTROCNEMIUS WITHOUT CHANGES ON ACHILLES TENDON AFTER OCCLUSIVE

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Introduction Occlusive strength training (OST) is shown like an alternative to intensive training in a previous results have shown a marked increase in muscular size and strength. OST combine low-intensity exercise (20-30% 1-RM) with blood flow restriction (BFR) (Pope et al., 2013). However there is not many papers about the effects of this training on tendon. It is know that the tendon suffers some adaptation to physical loading (Heinemeier & Kjaer, 2011) and recently Kubo et al. (2006) reported that after 12-weeks of OST specific tendon and tendon properties remain without changes. Present study show acute Achilles tendon responses and muscle changes to OST. Methods 12 male aged 24 (4) years and 3 female aged 27 (3) with a minimum of 1 year of strength training experience were recruited. OST (30% 1RM and 30% of maximum pressure occlusion) was applied in dominant leg during 3 sets of 15 repetitions in plantar flexion using a leg press machine. The contralateral leg was used as a control group. The thickness of Achilles tendon was measure in each subject before the testing, immediately after exercise and 24 hours after exercise by ultrasound (Mindray, Z6). Results After apply the Wilcoxon test we didn't find a significant different ( $p > 0.05$ ) between groups or between inter-group for Achilles tendon thickness OST pre 0.51 cm; OST post 0.43 cm; OST post24 0.50 cm; Control pre 0.50 cm; Control post 0.46 cm; Control post24 0.51 cm. We notice a significant difference in gastrocnemius thickness OST pre 1.77 cm; OST post 2.04 cm ( $p < 0.05$ ); OST post24 1.96 cm; Control pre 1.73 cm; Control post 1.86 cm; Control post24 1.84 cm. Discussion There is not significant difference between the control group and the occlusive group. Therefore, it is suggest that the occlusive condition does not produce any acute disturbance on tendon. Our data are consistent with Kubo's data (2006). We find acute and transient increase in cross-sectional area attributable to modifications in water content (Loennecke et al., 2012). Taking these data together it can be suggested that OST maybe a potentially useful protocol to improve muscular fitness without tendon impairments and for this could be useful for individuals who cannot lift sufficiently high loads to increase muscle size and strength. References Heinemeier KM, Kjaer M. (2011) J Musculoskelet Neuronal Interac, 11,115-23. Pope ZK , Willardson, JM, Schoenfeld BJ. (2013). J Strength Cond Res, 27, 2914-26. Kubo K, Komuro T, Ishiguro N , Tsunoda N, Sato Y, Ishii N, Kanehisa H, Fukunaga T. (2006). Journal of Applied Biomechanics, 22,112-119. Loennecke JP, Fash CA, Rossow LM, Abe T, Bemben MG. (2012) Medical Hypotheses, 78, 151-154.

## EFFECTS OF REHABILITATION EXERCISE AND TAPING ON MUSCLE ELECTROMYOGRAPY, PAIN AND RANGE OF MOTION IN JUDO ATHLETES WITH SHOULDER SUBLUXATION

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The purpose of this study is to clarify the effect of Rehabilitation exercise and taping on joint muscle activity, joint working range, and joint pain. The study is evidenced by rehabilitation program on patients with shoulder joint subluxation patient of judo player, which the patients underwent taping and rehabilitation exercise. In case of internal rotation, taping showed noticeable interaction with supraspinatus tendon. For deltoid and latissimus dorsi, however, there were increase of numbers but not critical. External rotation, on the other hand, while the taping did not appeared to be interactive with supraspinatus tendon though there were increase of numbers, it demonstrated noteworthy interactions with deltoid and latissimus dorsi. Statistically noticeable result was shown from the change on joint working range of motion, abduction, and extension with increasing of ROM after the taping. Self-awareness of pain was decreased among taping group, but not critical. The study showed positive result on both rehabilitation exercise group and taping group of judo subluxation patients, but the group with two method combined together demonstrated the best result. As a result, mix of the two program offers the best resolution for subluxation patients. It is suggestive that more specified experiment through isokinetic equipments should be accompanied to research myofunction restoration in depth.

## CHRONIC EFFECTS OF WHOLE BODY VIBRATION ON EMG AND TORQUE PRODUCTION OF KNEE EXTENSOR MUSCLES IN ACUTE STROKE PATIENTS

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**Introduction.** Vibration exercise is a novice method to restore muscle balance and neuromuscular problems of stroke patients. It was found previously that the isometric and concentric torque of the knee extensors increased significantly after six weeks of WBV intervention on stroke patients (Tankisheva et al., 2013). However, in another study 17 sessions of WBV training did not improve the strength parameters of stroke patients (Marín et al., 2013). The aim of this study was to examine the chronic effect of WBV on the isometric and eccentric torque and activity of the knee extensor muscles and the co-activation pattern. **Methods.** 16 voluntary stroke patients participated in this study, 8 women and 8 men (age= 58.2± 9.4 yrs). Subjects were divided randomly in two equal groups: vibration group (V) and control group (C). Subjects in V received 4 weeks (3 times a week) of WBV intervention. The vibration frequency ranged between 15-25 Hz, with 5 mm amplitude. Unilateral (UL) and bilateral (BL) isometric (IC) and eccentric (EC) torque of knee extensor muscles were measured by Multicont II dynamometer, and the corresponding EMG activity of the vastus medialis (VM) and vastus lateralis (VL) and biceps femoris (BF) muscles were recorded simultaneously before and after the 4-week intervention. **Results.** The UL and BL maximal IC increased by 45.2% and 45.6%, respectively in the paretic leg of the V group. The bilateral deficit decreased significantly in the V group ( $p=0.010$ ). The UL and BL EC torque of paretic leg increased by 26.3% and 31.9%, respectively in the V group. The changes were not significant at C group neither in the strength nor in the EMG activity parameters ( $p>0.05$ ). The EMG activity of the VM and VL muscles significantly improved, while the co-activation decreased during the contractions ( $p\leq 0.05$ ) in the injured leg in the V group, while remained unchanged in the C group ( $p>0.05$ ). **Discussion.** Our results suggest that the WBV caused significant changes in the paretic knee extensors. Increased strength parameters seem to be resulted from the changes in the activity pattern of the muscles around the knee. In this way, presumably the transmission of the functions of the motor area can be accelerated via the WBV. **References** Marín, PJ, Ferrero, CM, Menéndez, H, Marín, J, Herrero, AJ. (2013) *Am J Phys Med Rehabil* Tankisheva, E, Boqaerts, A, Boonen S, Feys, H, Verschueren, S. (2013) *Arch Phys Med Rehabil* Contact ancsi.peter@gmail.com

## THE EFFECTS OF DRY NEEDLING VERSUS MANUAL PRESSURE RELEASE OF MYOFASCIAL TRIGGER POINTS ON HIP MUSCLE LENGTH AND STRENGTH

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**Background:** It is widely accepted by clinicians and researchers that myofascial trigger points (MTrPs) can cause pain and provoke motor dysfunctions such as muscle weakness, muscle imbalance and altered motor recruitment. Muscle length and strength imbalances and flexibility impairments at the hip can cause abnormal distribution of forces and stress across the joint, resulting in injury to the hip, low back and pelvis (Sahrmann, 2002; Van Dillen et al, 2008). MTrP treatment methods are proposed to improve muscle flexibility, strength, function and pain. There is little evidence as to whether these methods are effective in treating these issues around the hip and buttock region, or which method is more effective. The purpose of this study was to investigate the effectiveness of dry needling versus manual pressure release of MTrPs on the length and strength of two hip muscles. **Methods:** 36 subjects were recruited from male athletes that participate in a multidirectional sport at least three times per week. Subjects were required to have MTrPs in their piriformis and gluteus medius muscles and reduced flexibility on hip flexibility tests. Subjects were randomly divided into two groups; group 1 would receive dry needling and group 2 would receive manual pressure release. Once recruited, subjects attended 2 testing sessions. At session 1 the subject received their allotted intervention to their piriformis or gluteus medius muscle. Seven days later, at session 2 the subject received their allotted intervention to the muscle not treated on session 1. Muscle length, muscle strength, pressure pain threshold (PPT) and stretch location was assessed immediately before and immediately after the intervention. **Results:** Data was analysed for significance ( $p<0.05$ ) between pre and post intervention within the groups as well as between groups. Results indicate both treatments cause a significant increase in muscle length. There are observable decreases in muscle strength following both treatments, with dry needling of the gluteus medius muscle resulting in a significant decrease in hip abduction strength. Only manual pressure release significantly improved PPT. Between groups, strength decreased significantly more following dry needling than manual pressure release. **Discussion:** Dry needling and manual pressure release appear to increase muscle length and decrease isometric muscle strength immediately post treatment. Further investigation is required to establish if these effects translate into performance changes. **References:** Sahrmann, S. (2002). *Diagnosis and Treatment of Movement Impairment Syndromes*. St. Louis, MO: Mosby. Van Dillen, L.R., Bloom, N.J., Gombatto, S.P., Susco, T.M. (2008). *Phys Ther Sport* 9(2) 72-81

## BACK TO WORK AS FIREFIGHTER WITH A STOMA AFTER RECTAL CARCINOMA: A CASE REPORT ON EXERCISE AND CANCER

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**Background:** A stoma is a surgically created opening of the abdomen to discharge stool. It is associated with weakened abdominal muscles and an increased risk of hernia (H) during physically demanding tasks like fire fighting. Colorectal cancer patients with a stoma are furthermore deconditioned through anti-cancer therapy. This case study reports how a firefighter with rectal carcinoma and a permanent stoma was trained to regain operational fitness. **Case study:** A 44 year old firefighter (178 cm, 82 kg) with an adenocarcinoma of the rectum (diagnosed 24 months before) was submitted to the exercise expert consultation of our comprehensive cancer center. He had received neoadjuvant radiochemotherapy and surgery. After two temporary ileostomies, a permanent colostomy was performed 12 weeks before baseline assessment. The patient was physically inactive since diagnosis and unable to work. To regain occupational fitness, we administered a 6-month training program consisting of three phases: a 2-month preparation phase, a 2-month individually supervised training phase, and a 2-month group based training phase. The program included sensorimotor, aerobic and resistance training of increasing volume and intensity. Cardiopulmonary exercise tests (CPET) and isometric strength tests were performed at baseline and after each phase. Training frequency varied from 1–3 sessions/week, although 2–5 sessions/week were prescribed. A psychosocial counselling slightly improved the situation. Peak power output in the CPET was 150, 158, 167, and 192 W at baseline, 2, 4, and 6 months. Peak oxygen uptake (VO<sub>2</sub>peak) increased from 1.56 l/min (19 ml/min/kg) to 2.39 l/min (29 ml/min/kg). Maximal isokinetic peak torque (MIPT) of the knee extensors was 138.0, 165.5 and 196.5 N at baseline, 4 and 6 months. MIPT of the elbow and hip flexors in-

creased from 51.8 to 66.0 Nm and 213.8 to 239.7 Nm, respectively. The firefighter passed a test for occupational fitness shortly after the 6 months test and was permitted to work in an exterior crew on a pump truck. Conclusion: Regaining occupational fitness for physically demanding tasks like firefighting is possible in cancer survivors with a stoma through an individually tailored and supervised exercise program. Training can therewith prevent from unemployment. However, sufficient time and psychosocial support might be needed depending on the individual situation. References: (1) Turnbull GB. Exercise and ostomy. *Ostomy Wound Manage*, 50(3):22-4, 2004.

### **AEROBIC EXERCISE IMPROVES THE EXPRESSION OF ACTIVITY-RELATED CYTOSKELETON ASSOCIATED PROTEIN IN THE HIPPOCAMPUS OF LACTATIONAL DEHP-EXPOSED RATS**

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Introduction Exercise can provide beneficial effects on brain function (Singh and Staines, 2015). Di-(2-ethylhexyl)-phthalate (DEHP), an endocrine disruptor, has been found to exert toxic effects by reducing the levels of BDNF and hippocampal atrophy in rats. (Smith and Holahan, 2014). In this study, we conducted an experiment regarding the effects of aerobic exercise on novelty-induced expression of activity-related cytoskeleton associated protein (Arc), an important immediate-early gene involved in synaptic plasticity, in the hippocampus of young male rats receiving postnatal DEHP exposure. Method Rat dams were fed with vehicle or DEHP (10mg/kg per day) during lactation. After weaning, the male offspring were divided into 4 groups: control (C), DEHP (D), exercised control (Cex), and exercised DEHP (Dex). Exercised rats were trained on treadmill every day from 3 weeks of age for 5 weeks. At the age of 8 weeks, the rat were exposed to a novel environment for 5 min and then returned to their home cage for 60 min to induce the expression of Arc in the hippocampus. After novelty exploration, the hippocampus was collected for Western blotting. Result The expression of Arc was significantly decreased in the D group compared to the C group, in addition, the novelty-induced Arc expression was improved in the Dex group compared to D group. Discussion According to the result, lactational DEHP exposure may impair the novelty-induced Arc expression in the hippocampus, suggesting an impairment of synaptic plasticity in the DEHP-exposed rats. Meanwhile, aerobic exercise during the childhood-adolescence can restore the synaptic plasticity by improving the novelty-induced Arc expression in the hippocampus of DEHP-exposed young male rats. References 1. Singh AM, Staines WR. The Effects of Acute Aerobic Exercise on the Primary Motor Cortex. *J Mot Behav*. 2015, 7:1-12. 2. Smith CA, Holahan MR. Reduced hippocampal dendritic spine density and BDNF expression following acute postnatal exposure to di(2-ethylhexyl) phthalate in male Long Evans rats. *PLoS One*. 2014, 9(10):e109522.

### **AEROBIC EXERCISE IMPROVES THE EXPRESSION OF CANNABINOID RECEPTORS TYPE 1 RECEPTOR IN LACTATIONAL DEHP-EXPOSED RATS**

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Introduction Studies indicate that aerobic exercise improves the learning and memory, as well as reduces the risk of neurodegenerative diseases. Cerebellum, an important role in motor coordination and motor skill learning, is also benefited by exercise (Kim et al., 2013). Di-(2-ethylhexyl)-phthalate (DEHP), a plasticizer applied in polyvinyl chloride manufacture, is regarded as an endocrine disruptor. It has been reported that perinatal treatment of DEHP leads to impairment of nervous system (Smith et al., 2011). Because the function of cerebellum is modulated precisely by cannabinoid receptor type 1 (CB1R), an attempt was made to reveal the effect of exercise on the cerebellar expression of CB1R in the lactational DEHP-exposed young male rats. Method Rat dams were fed with vehicle or DEHP (10mg/kg per day) during lactation. After weaning, the male offspring were divided into 4 groups: control (C), DEHP (D), exercised control (Cex), and exercised DEHP (Dex). Exercised rats were trained on treadmill every day from 3-weeks of age for 5 weeks. At the age of 8 weeks, animals were subjected to rotarod test to assess the motor coordination and then their cerebellar CB1R were analyzed by Western blotting. Result The performance on rotarod was impaired in the D group, which indicated the impairment of motor coordination in these rats. Exercise improved the motor coordination in the Dex group. The cerebellar Purkinje cell marker calbindin-D28K was not affected by lactational DEHP exposure. An upregulation of cerebellar CB1R was observed in the D group, whereas a normalization of cerebellar CB1R in the Dex group was found when compared to the C group. Discussion Because the expression of calbindin-D28K is not affected by lactational DEHP exposure, the reduction of Purkinje cells may be not responsible for the impairment of motor coordination in the DEHP-exposed rats. However, the upregulation of cerebellar CB1R in the DEHP-exposed rats suggests that interference of endocannabinoids system in the cerebellum of DEHP-exposed animal. Exercise during childhood-adolescent period may improve the motor coordination by normalization of the endocannabinoids system in lactational DEHP-exposed rats. These evidence show that aerobic exercise may provide beneficial effects on protection of cerebellar function against DEHP exposure. References 1. Kim JE, Shin MS, Seo TB, Ji ES, Baek SS, Lee SJ, Park JK, Kim CJ. Treadmill exercise ameliorates motor disturbance through inhibition of apoptosis in the cerebellum of valproic acid-induced autistic rat pups. *Mol Med Rep*. 2013;8(2):327-34. 2. Smith CA, Macdonald A, Holahan MR. Acute postnatal exposure to di(2-ethylhexyl) phthalate adversely impacts hippocampal development in the male rat. *Neuroscience*. 2011;193:100-8

### **AEROBIC EXERCISE IMPROVES THE ACTIVATION OF AKT AND ERK SIGNALING IN THE MOTOR CORTEX OF LACTATIONAL DEHP-EXPOSED ADULT MALE RATS**

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Introduction Di-(2-ethylhexyl)-phthalate (DEHP), a plasticizer usually applied in polyvinyl chloride manufacture, is regarded as an endocrine disruptor to exert adverse effects on the brain function (Sun et al., 2014). Exercise has been identified as a strategy for ameliorating a range of cognitive dysfunction in humans and animals (Singh and Staines, 2015). In this study, we conducted an experiment regarding the effects of aerobic exercise on motor skill-induced activation of Akt and Erk signaling in the cortex of young adult male rats receiving postnatal DEHP exposure. Methods SD rat dams were fed with vehicle or DEHP (10mg/kg/day) during lactation. After weaning, the male offspring were divided into 4 groups: control (C), DEHP (D), exercised control (Cx), and exercised DEHP (Dx). Exercised rats were trained on treadmill every day from 3-weeks of age for 5 weeks. At the age of 8 weeks, rats were trained to traverse a runway apparatus for 5 times to induce the activation of Akt and Erk signaling in the motor cortex. After one hour of behavioral stimulation, rats were sacrificed and their motor cortices were analyzed by Western blotting to detect the phosphorylations of Akt and Erk. Results Traverse time of crossing the runway apparatus was increased in the lactational DEHP-exposed rat. Exercise decreased the traverse time in the exercised DEHP-exposed animals, indicating an improvement of motor skill in these rats. Western blotting showed decreased phosphorylations of Akt

and Erk in the motor cortex of DEHP-exposed rats. After exercise for 5 weeks, the phosphorylations of Akt and Erk were improved in the exercised DEHP-exposed animals. Discussion After motor skill learning, the phosphorylation of Akt and Erk signaling indicates the activation of neural plasticity in the motor cortex. In this study, the phosphorylation of Akt and Erk signaling was decreased in the DEHP-exposed rats, suggesting the impairment of neural plasticity in the DEHP-exposed rats. Aerobic exercise during early life may ameliorate the adverse effects of lactational DEHP exposure on motor skill learning-induced neural plasticity, which is revealed by the improvement of phosphorylation of Akt and Erk signaling in the motor cortex after exercise in the DEHP-exposed rats. References 1. Singh AM, Staines WR. The effects of acute aerobic exercise on the primary hippocampus. *J Mot Behav.* 2015, 7:1-12. 2. Sun W, Ban JB, Zhang N, Zu YK, Sun WX. Perinatal exposure to Di-(2-ethylhexyl)-Phthalate leads to cognitive dysfunction and phospho-tau level increase in aged rats. *Environ Toxicol.* 2014, 29(5):596-603.

### THE IMPAIRED CEREBRAL EXPRESSION OF ACTIVITY-RELATED CYTOSKELETON ASSOCIATED PROTEIN IN PHTHALATE-EXPOSED RATS CAN BE AMELIORATED BY AEROBIC EXERCISE

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Introduction Di-(2-ethylhexyl)-phthalate (DEHP), a plasticizer usually applied in polyvinyl chloride manufacture, is regarded as an endocrine disruptor to exert adverse effects on the brain function (Sun et al., 2014). Exercise has been proposed as a strategy for ameliorating a range of cognitive dysfunction (Singh and Staines, 2015). In this study, we conducted an experiment regarding the effects of aerobic exercise on motor skill-induced activity-related cytoskeleton associated protein (Arc) expression in the motor cortex of young adult male rats receiving postnatal DEHP exposure. Methods SD rat dams were fed with vehicle or DEHP (10mg/kg) during lactation. After weaning, the male offspring were divided into 4 groups: control (C), DEHP (D), exercised control (Cx), and exercised DEHP (Dx). Exercised rats were trained on treadmill every day from 3-weeks of age for 5 weeks. At the age of 8 weeks, rats were trained to traverse the runway apparatus for 5 times to induce the expression of Arc in the motor cortex, and were sacrificed to collect proteins from their motor cortex. Western blotting was used to reveal the level of Arc expression in the motor cortex. Results Traverse time of crossing the runway apparatus was increased in the lactational DEHP-exposed rat. Exercise decreased the traverse time in the exercised DEHP-exposed animals, indicating an improvement of motor skill in these rats. Western blotting showed decreased motor skill learning-induced Arc expression in the motor cortex of DEHP-exposed rats. After exercise for 5 weeks, the expression of Arc was improved in the exercised DEHP-exposed animals. Discussion The reduced activity-induced Arc level in the motor cortex of lactational DEHP-exposed rats suggests an adverse effect of DEHP on the synaptic plasticity. Aerobic exercise during early life may ameliorate the adverse effects of lactational DEHP exposure on motor skill learning-induced neural plasticity, which is revealed by the improvement of Arc expression in the motor cortex after exercise in the DEHP-exposed rats. References 1. Singh AM, Staines WR. The Effects of Acute Aerobic Exercise on the Primary motor cortex. *J Mot Behav.* 2015, 7:1-12. 2. Sun W, Ban JB, Zhang N, Zu YK, Sun WX. Perinatal exposure to Di-(2-ethylhexyl)-Phthalate leads to cognitive dysfunction and phospho-tau level increase in aged rats. *Environ Toxicol.* 2014, 29(5):596-603.

### PATIENT-REPORTED OUTCOMES BUT NOT DEMOGRAPHIC FACTORS ARE ASSOCIATED WITH NORMAL MUSCLE FUNCTION 2-5 YEARS AFTER ANTERIOR CRUCIATE LIGAMENT INJURY: A CROSS-SECTIONAL STUDY

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Background Treatment after anterior cruciate ligament (ACL) injury includes rehabilitation, with or without reconstructive surgery. Reaching normal muscle function is considered important, as it is associated with return to sports and preventing long-term joint problems. The influence of demographic and patient-reported outcomes for achieving normal muscle function is largely unknown. Purpose In a cross-sectional cohort study, examine associations of patient-reported outcomes and demographic factors with muscle function after ACL injury/reconstruction. Methods Fifty-four patients were measured mean 3 years (SD 0.85) after ACL injury/reconstruction to determine whether knee muscle power (leg extension, leg flexion, and leg press) and hop performance (single-leg vertical jump, single-leg hop for distance, and side-hop) scores had normalized. A Limb Symmetry Index (LSI; injured leg divided by uninjured and multiplied by 100)  $\geq 90\%$  was considered normal. Age, gender, body mass index (BMI), activity level (Tegner Activity Scale [TAS]), and the Knee Injury and Osteoarthritis Outcome Score subscales (KOOS; Pain, Symptoms, Activities of Daily Life [ADL], Activities in Sport and Recreation [sport/rec], Quality of Life [QOL]) were analyzed using simple logistic regressions to determine their association with muscle function. Results A higher TAS score (odds ratio 1.40, 95% CI 1.0-1.9,  $p = 0.02$ ) and better scores on KOOS QOL (odds ratio 1.03, 95% CI 1.0-1.1,  $p = 0.02$ ) were significantly associated with normal knee extension LSI; i.e., with each unit increase of TAS and KOOS QOL, the likelihood of reaching normal LSI increased 40% and 3%, respectively. Each increase in TAS score (odds ratio 1.42; 95% CI 1.0-2.0,  $p = 0.03$ ), and better scores on KOOS subscales (odds ratio increases of 4-15%) were associated with normal LSI for vertical jump. Better scores on KOOS sport/rec (odds ratio 1.03, 95% CI 1.0-1.1,  $p = 0.02$ ;) and KOOS QOL (odds ratio 1.03, 95% CI 1.0 - 1.1,  $p = 0.03$ ) were associated with normal LSI of the side-hop test. Age, gender or BMI showed no associations with muscle function. Conclusions Higher activity level and better self-reported outcomes on the disease-specific questionnaire KOOS were associated with normal LSI of knee extension power and single-leg hop performance mean 3 years after ACL injury. Demographic variables showed no such association. These results warrant the need for future research into the psychological factors involved in ACL injury rehabilitation; their relation to outcomes commonly used to measure success and to improve treatment. Contact Niklas.cederstrom@med.lu.se

### THE ANALYSIS OF NEUROMUSCULAR ACTIVITY AND MUSCULAR OXYGENATION THROUGH DIFFERENT MOVEMENT CADENCES DRUING IN-WATER AND ON-LAND KNEE EXTENSION EXERCISE

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Introduction The prevalence of sport injuries is relatively higher in lower extremity (Hootman et al., 2007). Thus, appropriate rehabilitation training strategies are substantial for injured athletes who need to quickly return the field. The physical properties of water allow it to provide a number of rehabilitation and exercises that accelerate recovery, train muscular strength, and permit a larger range of movements. Previous exercises in aquatic therapy research focused on isometric or upper limbs dynamic exercise model (Pöyhönen et al., 1999; Castillo-Lozano et al., 2013). To our knowledge, there has yet to be any studies investigating neuromuscular activity, oxygen saturation, and perceived exertion in lower-extremity dynamic aquatic exercise models. The lack of these investigations restricts the design of

aquatic exercises and training and clinical applications. The purpose of this study was to compare the different cadences of knee extension exercises in water and on land, and differences in the neuromuscular activation of quadriceps femoris, muscular oxygenation and rating of perceived exertion. Methods Seventeen young women participated in this study, and the subjects were randomly allocated to perform loaded knee extension/flexion exercises (2.4 kg load) in water and on land at four different cadences of 30, 50, 70, and 90 beats per minute (bpm). Heart rate (HR), rating of perceived exertion (RPE), electromyography for the extent of muscular activity (EMG), blood flow (BF) and total saturation index of oxygen(TSI) were measured. Response values of measured parameters at each cadence were obtained by subtracting the resting values from the indicator values measured at the respective cadences. A two-way ANOVA repeated measurement analysis was used to evaluate the differences in response values of EMG, HR, RPE, BF and TSI under different conditions (in water or on land) and cadences. Results RPE and muscular activation at 30 bpm in water were lower than those on land. EMG, RPE, and BF in water at 90 bpm were comparable to that on land. However, HR and TSI changes were higher in water compared to on-land. Discussion This study showed that the neuromuscular activity when performing knee extension exercises at 90 bpm in water was comparable to that of on-land. However, exercising in water at the same cadence evoked higher TSI responses and greater cardiovascular challenges. We recommend using the properties of water to alleviate the swelling around the injured area and enhance regional blood circulation and metabolism at early stages of rehabilitation. Exercise may start from a more comfortable pace of 30 bpm and then gradually increased as needed to reach 90 bpm for effective training. References Hootman, J.M., Dick, R., Agel, J.. (2007). *J Athl Train*, 42, 311-19. Pöyhönen, T., Keskinen, K. L., Hautala, A., Savolainen, J., & Mälkiä, E. (1999). *Eur J Appl Physiol*, 80, 52-56. Castillo-Lozano, R., Cuesta-Vargas, A., & Gabel, C. P. (2013). *J Shoulder Elbow Surg*, 23(2), 159-165. Contact: chienkueiyu@gmail.com

### **ACUTE SUPPLEMENTATION WITH RESVERATROL DOES NOT IMPROVE FLOW-MEDIATED DILATION IN CORONARY ARTERIAL DISEASE ELDERLY PATIENTS**

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Coronary arterial disease (CAD) is characterized by the building up of plaque in the arteries of the heart and is a serious cause of morbidity and mortality. Abnormal constriction of the heart arteries might lead to ischemia and myocardial infarction. Common risk factors for the development of CAD include hypertension, hyperlipidemia, obesity and lack of exercise. Betablocker agents or nitrate preparations are routinely prescribe to CAD patients aiming to reduce blood pressure and improve dilation of the artery. Resveratrol (RV) is a polyphenol with multiple cardiovascular and metabolic effects. In humans, RV has been shown to increase nitric oxide bioavailability and as a consequence enhance endothelium-dependent vasodilation. Methods: The study was performed in a randomized double blind placebo controlled trial. After screening and signing informed consent, 15 CAD patients (aged  $67.75 \pm 7.07$  years;  $80.5 \pm 13.6$  kg;  $172.1 \pm 7.07$  cm and BMI of  $27.1 \pm 3.65$  kg/m<sup>2</sup>), routinely referred for cardiac rehabilitation at University Hospital Leuven were assigned to flow-mediated dilation (FMD) measurements under acute supplementation with RV (21st century alternatives, UK) and placebo. The subjects were required to consume 330 mg of RV or placebo (in the forms of pills) with each meal during the three days (1g/day) prior to testing. All of the tests were performed between 08:00 and 10:00 am with a seven-day rest and washout period in-between. Results: All calculations were analyzed using GraphPad Prism. To compare parameters before and after RV a paired-sample t test was used. Statistical significance was set at  $p < 0.05$  (2-tailed). No difference in initial diameter was observed between treatments ( $p = 0.75$ ). Further, treatment with RV resulted in no increased FMD ( $p = 0.68$ ). Conclusion: Doses of 1mg/day of RV are considered to be high while having no secondary adverse effects in humans. In our study, endothelial function as evaluated by FMD was not enhanced by acute supplementation with RV in CAD elderly patients.

### **OUTCOMES FOLLOWING THE INTERVENTION OF THE MULTIDISCIPLINARY APPROACH FOR A PATIENT WITH KNEE JOINT OSTEOARTHRITIS IN TAIWAN: A CASE REPORT**

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Introduction Osteoarthritis is the most common cause of musculoskeletal pain and disability in the knee joint. The increased loading in the knee joint causes further deterioration of the joint cartilage and produced the symptom. Pain relief and excessive load removed are very important principles in OA knee management. The purpose of this study is to describe outcomes from the multidisciplinary approach for a patient with severe knee pain caused by orthoarthritis in Taiwan. Methods A 46-year-old female presented L't knee pain and had difficulty to perform functional activities. The X ray finding showed OA change and narrowing joint space. According to Kellgren and Lawrence system, the severity is grade 3. The score of the Western and McMaster Universities Index(MOMAC) indicated disability and the knee flexion ROM was slightly limited. Treatment consisted of the low intensity laser therapy for cartilage. The application of therapeutic taping supported knee joint and decreased the pressure in the joint space. Finally, the strengthening exercise of lower extremity was instructed especially in gluteus maximum and medius. This case accepted 12 treatment visits over 4 weeks. Results The pain scale and the scores of WOMAC showed significant improvement. The pain scale decreased from 7 to 1. The scores of WOMAC improved from 66% to 8% after treatment. Discussion The laser therapy provides an analgesic and anti-inflammatory effect by increasing pain threshold in sensory nerve endings. In addition, laser irradiation stimulates collagen production and alters DNA synthesis. The therapeutic taping technique protected the knee joint and decreased the abnormal stress on the cartilage in weight bearing condition. The strengthening exercise of gluteus muscles improved the alignment and movement quality of pelvis and lower extremity. Appropriate alignment and movement of lower extremity maintained the effect of the multidisciplinary approach. Reference Rana S Hinman, Kay M Crossley, Jenny McConnell, Kim L Bennell.(2003) *BMJ*, 327(19) Emil Sobol, Anatoly Shekhter, Anna Guller, Olga Baum, Andrey Baskov. (2011). *J Biomed Opt*, 16(8) Dinesh Bhatia, Tatiana Bejarano, Mario Novo. (2013). *J Pharm Biomed Sci*, 5(1), 30-38.

### **MORPHOLOGICAL CHARACTERISTICS OF MUSCLE FASCICLE IN THE MEDIAL GASTRONEMIUS DURING RAMPING CONTRACTION WITH AND WITHOUT AN ACHILLES REPAIR**

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Introduction A compliant tendon in repaired Achilles tendons has been observed within one year after surgical management (Wang et al., 2013). Whether this phenomenon affects fascicle behavior in the muscle, however, remains unclear. The aim of this study was to

measure the fascicle morphologies, including angle and curvature radius, of the medial gastrocnemius muscle in legs with and without a repaired Achilles, and to investigate the asymmetry between different force levels during a ramping isometric contraction. Methods Seven subjects with an Achilles tendon repair within the past 6 months were recruited. Bilateral ultrasonographic measurements were performed with each subject lay prone with ankles hanging over the edge of the bed and positioning at 90 degrees. During each test, subjects were asked to perform at least three repetitions of a five-second ramping plantarflexion to maximum voluntary isometric contraction (MVIC), e.g. 30, 60, and 90%, each of which was then followed by a five-second period of muscle relaxation. The fascicle angle and curvature radius were recorded at different contraction levels. The asymmetry index (AI) was calculated according to the following formula:  $AI = 1 - (\Delta_{\text{healthy}} / \Delta_{\text{repaired}})$ . A small absolute AI represented symmetric fascicle behaviors between the uninjured leg and the repaired leg. Results The AI of the fascicle angle decreased and neared zero as muscle force increased to 90% MVIC from 30% MVIC. The AI of the fascicle angle at 30% MVIC had a significantly higher value than the AI at 90% MVIC ( $p < 0.017$ ). There was a tendency for the AI of the fascicle curvature radius to increase from negative values to values close to zero as the muscle force increased from 30% MVIC ( $p > 0.017$ ). Discussion This study found that the level of symmetry between uninjured and repaired legs in terms of changes in muscle fascicle angles was greater during a vigorous contraction than during a contraction of mild intensity. We have previously argued that the differences in muscle fascicle behavior at different levels of muscle contraction may be contributed by a compliant tendon after surgical management (Wang et al., 2013). Insignificant results with regard to the AI of fascicle curvature may imply that changes in muscle hardness at different levels of muscle contraction are similar (Wang et al., 2009). Measuring the aponeurosis stiffness is suggested as a means of clarifying the mechanisms of symmetries of muscle fascicle behaviors between uninjured and repaired Achilles. References Wang HK, Wu YK, Lin KH, Shiang TY. (2009). *Man Ther*, 14(3), 264-269. Wang HK, Chiang H, Chen WS, Shih TT, Huang YC, Jiang CC. (2013). *Arch Phys Med Rehabil*, 94(8), 1590-1598.

### EFFECT OF STATIC STRETCHING ON SHOULDER RANGE OF MOTION AND PITCHING BIOMECHANICS IN UNIVERSITY STUDENT PITCHERS

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Introduction: Recently, there have been a growing number of pitching-related upper extremity injuries that require surgery because of an increase in participation volume (Olsen et al., 2006). Pitching-related upper extremity injuries often decrease the shoulder range of motion (ROM) and increase the shoulder joint loading; therefore, it is important to increase the shoulder ROM and decrease the shoulder joint loading. Clinically, static stretching (SS) is performed to increase the shoulder ROM, which is believed to decrease the shoulder joint loading. However, the effects of SS on pitching biomechanics are unclear. Purpose: The purpose of this study was to investigate the effect of SS on the shoulder ROM and pitching biomechanics in university student pitchers. Methods: Internal and external rotation ROM and three-dimensional pitching biomechanics (Mac3D System, Motion Analysis) were measured before (PRE) and after SS intervention (POST) in university student pitchers (age:  $19.2 \pm 0.6$  years). SS intervention comprised three types of SS intervention, with each type comprising three sets of 30 sec. The kinetic variables calculated were the peak shoulder joint moment and joint moment at maximum shoulder external rotation. Results and Discussion: There were significant increases in the internal and external rotation ROMs after SS (internal rotation: PRE:  $41.8 \pm 12.8$  degrees, POST:  $47.8 \pm 11.4$  degrees,  $p < 0.01$ ; external rotation: PRE:  $127.7 \pm 7.5$  degrees, POST:  $131.8 \pm 7.4$  degrees,  $p < 0.01$ ). However, there were no significant changes in the kinetic variables. Briefly, SS intervention effectively increased the shoulder internal and external rotation ROM; however, it did not decrease the joint loading during pitching. Because an increase in the shoulder joint loading is associated with a variety of pitching-related upper extremity injuries (Oyama et al., 2013), the results suggested that SS intervention could not decrease the risk of pitching-related upper extremity injuries. References: Olsen SJ II, et al. Risk factors for shoulder and elbow injuries in adolescent baseball pitchers. *Am J Sports Med*. 34(6):905-912, 2006. Oyama S, et al. Effect of excessive contralateral trunk tilt on pitching biomechanics and performance in high school baseball pitchers. *Am J Sports Med*. 41(10):2430-2438, 2013.

### MOTOR IMAGERY COMBINED WITH ACTION OBSERVATION OF CHOPSTICK USE FACILITATES MOTOR CORTEX EXCITABILITY IN THE DOMINANT HEMISPHERE

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Introduction Motor imagery plays an important role in motor learning for patients with poststroke hemiparesis. A previous study suggested that primary motor cortex (M1) excitability during motor imagery (MI) with action observation (AO) increased more than during motor imagery alone (Wright et al., 2014). However, the involvement of non-dominant M1 during MI with AO has received little attention. The purpose of this study is to examine change in excitability in dominant and non-dominant M1 during kinesthetic MI with AO of movement of the right or left hand. The imagery task utilized in this study was chopstick use, as it is commonly used in rehabilitation. Methods Nine neurologically healthy right-handed male subjects participated in this study. The subjects performed under two conditions: (1) control where the subjects were instructed to look a fixation cross displayed on the computer screen and (2) MI+AO where the subjects were instructed to imagine performing an action depicted with the right or left hand in a video. Under MI+AO conditions, a video displayed on the computer screen showed the right and left hand respectively of a male subject using chopsticks to grab a small tomato. Single-pulse transcranial magnetic stimulation (TMS) was performed using a Magstim 200 stimulator (Magstim, Gwyneth, Dyfed). TMS delivered 1.2 times the resting motor threshold intensity. Under each condition, motor-evoked potentials (MEPs) were recorded from the first dorsal interosseous (FDI) muscles of the right hand and left hand, respectively. Two-way repeated-measures analysis of variance (ANOVA) was performed to compare differences in MEP amplitudes between condition (MI+AO by right hand, MI+AO by left hand, control) and hemisphere (dominant and non-dominant). Results Repeated-measures ANOVAs showed significant interaction between the MI+AO condition and hemisphere, a significant main effect of MI+AO condition ( $p < 0.01$ ), and a significant main effect of hemisphere ( $p < 0.01$ ). Post-hoc testing found a significant increase in MEP amplitude during MI+AO with the right or left hand in the left hemisphere compared to that during control ( $p < 0.01$ ,  $p < 0.01$ ), whereas there was no significant increase in the right hemisphere. Discussion The main findings of this study are that MI combined with AO using chopsticks with either hand facilitates the motor cortex in the dominant hemisphere, whereas no facilitation is shown in the non-dominant hemisphere. This finding has implications for the use of MI combined with AO in rehabilitation. References Wright DJ, Williams J, Holmes PS. (2014). *Front Hum Neurosci*. 27(8):951.



## EMG EVALUATION OF THREE ELASTIC BAND EXERCISES FOR BEDBOUND PATIENTS

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**Introduction** Elderly medical patients who are being hospitalised in Denmark spend up to 17 hours a day in bed. Besides the risks for decreased balance, lung complications and bedsore, even few days of immobility induces a loss of muscle mass and muscle strength. Strength training is shown to counteract these effects. However, being hospitalised and newly operated limits the choice of suitable exercises and training equipment. Therefore, the aim of this study was to evaluate muscle activity during three elastic band exercises carried out in the hospital bed. **Methods** Seven healthy females (mean age 46, range 27-56 yrs, mean BMI 24, range 20-29) volunteered. Three elastic band strength exercises (shoulder extension, elbow extension and hip extension) using Thera-Band™, were evaluated. All exercises were performed while lying in bed with the elastic band fixed in the ceiling. Electromyography (EMG) was measured on 10 relevant muscles (5 upper body, 5 lower body muscles) with wireless MYON 320 (Myon AG Switzerland) and shown as mean peak and percentage of Maximum Voluntary Electrical activation (MVE) for each muscle. Individual 8 and 15 Repetition Maximum (RM) was pre-defined by a combination of elastic band resistance and length of the elastic band. Rate of perceived exertion (RPE) was measured by the Borg 10-point RPE scale. Results Shoulder extension primarily activated m. triceps brachii with a peak (mean (SD)) of 622.7  $\mu$ V ( $\pm$ 272.3) for 15RM, 616.2  $\mu$ V ( $\pm$ 224.5) for 8RM, and a relative muscle activation (mean (SD)) of 27.4% ( $\pm$ 2.3) MVE for 15RM and 29.4% ( $\pm$ 4.3) MVE for 8RM. Elbow extension primarily activated m. latissimus dorsi with a peak of 525.7  $\mu$ V ( $\pm$ 376.5) for 15RM, 466.8  $\mu$ V ( $\pm$ 329.5) for 8RM, and a relative muscle activation of 24.0% ( $\pm$ 4.0) MVE for 15RM and 25% ( $\pm$ 4.8) MVE for 8RM. The hip extension exercise primarily activated m. biceps femoris, with a peak of 337.2  $\mu$ V ( $\pm$ 170.3) for 15RM, 333.4  $\mu$ V ( $\pm$ 167.0) for 8RM, and a relative muscle activation being 25.5% ( $\pm$ 4.8) MVE for 15RM and 28% ( $\pm$ 6.7) MVE for 8RM. RPE for shoulder extension (Mean (SD)): 15RM = 8.3 ( $\pm$ 1.1), 8RM = 9 ( $\pm$ 0.8). Elbow extension: 15RM = 8.7 ( $\pm$ 1.0), 8RM = 8.7 ( $\pm$ 1.1). Hip extension: 15RM = 8.3 ( $\pm$ 1.0), 8RM = 8.3 ( $\pm$ 1.3). **Discussion** This is the first study using a fix-point in the ceiling for in-bed elastic band exercises. This, in combination with different levels of elastic band resistance and lengths makes an individual's adaptation to strength training feasible, even for bedbound patients. Furthermore the EMG and RPE measurements show that the three chosen exercises target different muscle groups. The study advocates using intensive strength training during a hospital stay. It is of great importance to look for new ways to facilitate a more optimal recovery period among elderly postoperative patients. Contact: sstensgaard@health.sdu.dk

## EFFECT OF FUNCTIONAL TRAINING ON PHYSICAL FITNESS AND GLYCEMIC CONTROL OF OLDER ADULTS WITH TYPE 2 DIABETES

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**EFFECT OF FUNCTIONAL TRAINING ON PHYSICAL FITNESS AND GLYCEMIC CONTROL OF OLDER ADULTS WITH TYPE 2 DIABETES 1: USC (Bauru, Brazil)** **Introduction** Functional training (FT) is recommended to improve motor skills of older persons, but their effects in treatment of type 2 diabetes (T2D) are not certain. Therefore, this study aimed to verify the effect of a FT program on physical fitness and glycemic control of older adults with T2D. **Methods** Twenty-five diabetics aged >60 yr were randomly assigned in two groups: training (TG, n = 13) and control (CG, n = 12). A progressive FT was conducted for 16 wk, 3 d/wk and 70 min/d. Before and after training program, were performed physical tests (chair stand, arm curl, sit-and-reach, timed up and go (TUG) and 6-min walk test (6MWT)) and glycemic analysis (fasting plasma glucose [FPG] and glycated hemoglobin [HbA1c]). Data were analyzed using Student's t-test with 5% significance level. Results Training induced significant improvement in arm curl (P < 0.01), sit-and-reach (P < 0.01), TUG (P < 0.01), 6MWT (P = 0.05) and HbA1c (P = 0.05) in post compared to pre-training. Between two groups, only arm curl (P < 0.01) and sit-and-reach test (P = 0.01) showed statistical differences. No significant changes were observed in chair stand test and FPG. **Discussion** In our study, we found improvement in most physical tests, which justifies recommendation of American College of Sports Medicine, prescribing FT to improve and maintain physical function of older persons (Garber et al., 2011). Chair stand test was the only one which no improvement was observed. This finding may be related to fact that, in older persons, T2D is associated with reduced muscle strength and worse muscle quality in lower limbs (Volpato et al., 2012). So perhaps a specific increase in exercise loads was needed to improve strength of these muscle groups. In glycemic analysis, although it has not been observed changes in FPG, HbA1c showed a decrease (-0,28%) in TG. However, this decrease was lower than that reported in meta-analysis involving other types of training, such as aerobic (-0,73%) and resistance (-0,57%) (Umpierre et al., 2011). Finally, we conclude that FT program proposed in this study improved physical fitness and glycemic control of older adults with T2D. Also, we suggest the association of FT with other types of training, such as aerobic and resistance, aiming to maximize benefits, mainly in relation to glycemic control. **References** Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, Nieman DC, Swain DP. (2011). Med Sci Sports Exerc, 43(7), 1334-1359. Umpierre D, Ribeiro PA, Kramer CK, Leitão CB, Zucatti AT, Azevedo MJ, Gross JL, Ribeiro JP, Schaan BD. (2011). JAMA, 305(17), 1790-1799. Volpato S, Bianchi L, Lauretani F, Lauretani F, Bandinelli S, Guralnik JM, Zuliani G, Ferrucci L. (2012). Diabetes Care, 35(8), 1672-1679. Contact adheubel@yahoo.com.br

## REASONS OF USING INDIVIDUAL OR GROUP FORMS OF REHABILITATION OF PEOPLE WITH SCOLIOSIS OF I-III DEGREES

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**Introduction** During the process of muscular activity the cosmetic changes of posture are very influenced by the anatomical and physiological features of spine. **Methods** The motions' number of 998 girls aged 8-16 years old with the scoliosis to 30o during the processes of flexion, extension, inclination and rotations both directions has been tested. **Results** The research has shown that 12% of the girls aged 8-9 years old with the scoliosis of I-II degrees have hypermobility below the normal in a lumbar part of spine (A-degree). 25% of girls have a level of hypermobility within the normal (B-degree). And 63% have the index of this parameter above the normal (C-degree). The surveyed people aged 15-16 years old have 62%, 27% and 11% of this parameter. 12-16 years old with the scoliosis of III degree have a hypermobility above the normal which dominates during the process of extension, 64% of the tested girls have shown this result. The opposite situation has been observed during the testing spine's mobility in the process of inclination forward at the sitting position. 78% of 8-9-years old girls, 66% of 9-10- years old girls and 72% aged 10-11 have had A-degree. Hypermobility has been noticed among 14% of girls aged 14-15 years old and among 21% - 15-16 years old. B-degree has been registered on average among 48% of adolescents aged 12 years. C-degree has been found among 29% and 34% of girls aged 14-15 and 15-16 years. Besides, during the research it has been noticed that

the mobility's rate in the process of flexion out of sitting position among 45% of the tested girls aged 12-16 years suffering of III-degree scoliosis exceeds 15 sm. The rotation's volume both sides over 90o (hypermobility is above normal) has been registered among 46% of 8-9 years old girls suffering of I-degree scoliosis. The number of adolescents with increased hypermobility was in average 3 times less. The largest number of tested people with the rotation to 70O (hypermobility is below normal) has been registered in the age of 12-13 years old (52%). Testing of the volume of body's flexion at the frontal surface has found that the number of girls with hypermobility is being reduced. In the process of evaluation the volume of body's flexion at the frontal surface in the group of the girls aged 12-16 years suffering of III-degree scoliosis it was found that 65% of tested has the limited amplitude of motions. Discussion The obtained information confirms that the volume of the spine's mobility at the various surfaces among children and adolescents with the different degree of scoliosis in the aged point of view essentially varies in the aspect of hypo- and hypermobility. We consider it efficient to use the group form of rehabilitation in the case of I-degree scoliosis and individual training with the combination of special exercises and massage in the case of II-III-degree of scoliosis. References Shklyarenko, A. Scoliosis and physical education: methodical textbook. - Volgograd: Volgograd Scientific Publishing House, 2007. - 196 p.

### **EFFECTS OF PROPRIOCEPTION-BASED EXERCISE ON HEART RATE VARIABILITY AND SENSORY PROCESSING IN CHILDREN WITH ADHD**

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**Introduction** Attention deficit hyperactivity disorder (ADHD) is one of the most prevalent neurodevelopmental disorders in children, and studies examining nervous system on this population have been increasing. Problems of sensory processing and heart rate variability (HRV) in children with ADHD have been reported in some studies, which indicated the lower level of nervous function in children with ADHD. Furthermore, the effects of enhanced proprioceptive inputs on amelioration of nervous system problems have been assumed in sensory integration theory (Su and Parham, 2014). However, the effects of proprioception-based exercise on nervous system in children with ADHD have not been fully explored. Thus, the purposes of this study were to investigate the effects of proprioception-based exercise on sensory processing and heart rate variability (HRV) in children with ADHD. **Methods** We recruited 20 children diagnosed with ADHD. These children were assigned into the proprioception-based exercise group (ADHD-EX; aged 9.7±1.1 years old) and control group (ADHD-CON; aged 9.1±1.7 years old). No group differences existed in height, weight, and ages. Seven weeks of proprioception-based exercise intervention, including running and resistant exercise, was conducted in ADHD-EX group for 30-40 minutes per day, 5 days per week. Sensory processing and HRV were measured by Sensory Profile (SP) and Polar heart rate monitor with accompanying software respectively at the baseline and the end of the intervention. **Results** Before intervention, no significant differences on HRV and sensory processing were found between two groups. After seven weeks of proprioception-based exercise, the mean RR (ms) in the ADHD-EX group was significantly greater than the ADHD-CON group, and the mean heart rate (bpm) in the ADHD-EX group was significantly lower than the ADHD-CON group. Also, the scores on multiple sensory processing and vestibular processing were significantly higher in the ADHD-EX group than the ADHD-CON group. **Discussion** This study indicated that proprioception-based exercise could improve the performance of nervous system in children with ADHD as measured by sensory processing and HRV. Our results suggest that proprioception-based exercise could be an appropriate activity to accompany regular intervention for children with ADHD (Verret et al., 2012). **References** Su CT, Parham LD (2014). *Am J Occup Ther*, 68(5), 546-554. Verret C, Guay M-C, Berthiaume C, Gardiner P, Béliveau L. (2012). *J Atten Disord*, 16(1), 71-80. Contact Chiatingsu@gmail.com

### **INFLUENCES OF EXERCISE AND PROTOCATECHIC ACID INTERVENTION ON BLOOD PRESSURE AND ENDOTHELIAL FUNCTION IN POSTMENOPAUSAL HYPERTENSION**

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**Introduction** Hypertension is one of the common cardiovascular diseases in postmenopausal women. Exercise training has been known to exert cardio-protective effects in patients with cardiovascular disease. Moreover, evidences have indicated that protocatechic acid (PA), a simple phenolic acid, has antioxidant and anti-inflammatory effects, and could improve cardiovascular health. However, whether exercise training and PA intervention positively influence blood pressure and endothelial function in postmenopausal hypertension remains unclear. Therefore, the aim of this study was to investigate the influences of eight-week exercise training and PA intervention on blood pressure and endothelial function in postmenopausal hypertensive rats. **Methods** Sixteen-week-old female spontaneously hypertensive rats (SHR) were divided into three groups: the ovariectomy group (SHR-O), the ovariectomy with exercise training group (SHR-OT), and the ovariectomy with PA group (SHR-OP). Also, the normotensive Wistar-Kyoto (WKY) rat was used as the normal control group. The exercise training was conducted by treadmill at moderate intensity for 1 hour/day, 5 days/week, for 8 weeks in the SHR-OT group. The SHR-OP group was supplemented with PA solution (200 mg/kg/day) in the daily water consumption for 8 weeks. After the intervention, the systolic/diastolic blood pressure was measured and thoracic aortas were isolated for the evaluation of endothelial function (i.e., vasorelaxation). The endothelium-dependent (acetylcholine, ACh) and endothelium-independent (sodium nitroprusside, SNP) vasorelaxation was evaluated by the organ bath system. **Results** After eight-week intervention, we found that systolic blood pressure was significantly ( $p < 0.05$ ) decreased in the SHR-OT and SHR-OP groups compared with the SHR-O group. However, no significant changes were found for diastolic blood pressure among four groups. Moreover, either exercise training or PA intervention significantly ( $p < 0.05$ ) improved the ACh-induced vasorelaxation in the SHR-OT and SHR-OP groups compared with the SHR-O group. However, no significant difference was found in the SNP-induced vasorelaxation among four groups. **Discussion** Our results indicated that either exercise training or PA intervention could reduce systolic blood pressure and improve the endothelium-dependent vasorelaxation in postmenopausal hypertensive rats. It suggested that exercise and PA intervention would ameliorate parts of cardiovascular function in the population of postmenopausal hypertension. **References** Barton M, Meyer MR. (2009). *Hypertension*, 54(1), 11-18. Liu CL, Wang JM, Chu CY, Cheng MT, Tseng TH. (2002). *Food Chem Toxicol*, 40(5), 635-641. MacDonnell SM, Kubo H, Crabbe DL, Renna BF, Reger PO, Mohara J, Smithwick LA, Koch WJ, Houser SR, Libonati JR. (2005). *Circulation*, 111(25), 3420-3428. Contact Email: yangailun@gmail.com

## EFFECTS OF DIFFERENT WARM-UP PROGRAMS ON FLEXIBILITY AND STRENGTH OF GASTROCNEMIUS MUSCLE

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**Introduction:** Warm-up programs comprise aerobic exercise, anaerobic exercise, and passive warm-up with heat modalities. Aerobic exercise promotes greater circulation compared with anaerobic exercise (Taylor et al., 1988). Passive warm-up raises the muscle temperature without muscle contractions (Sawyer et al., 2003). Therefore, it is possible that the effects of these warm-up programs are different; however, the differences are still unclear. **Purpose:** The aim of this study was to compare the effects of three different warm-up programs on the flexibility and strength of the gastrocnemius muscle. **Methods:** Fourteen healthy males (age:  $23.1 \pm 2.6$  years) performed three separate randomized conditions: (1) bike condition (10 min, 60 W), (2) hot condition (10 min, immersed their lower limb in 40°C water), and (3) MVC condition (10 min, five sets of 10 maximal voluntary contractions). The flexibility during passive ankle dorsiflexion and the muscle strength during an isometric contraction were measured prior to and following the warm-up. Muscle tendon unit (MTU) stiffness from 15 to 25 degrees of ankle dorsiflexion, ankle dorsiflexion range of motion (ROM), passive torque at ROM maximum, and peak torque during isometric contraction were measured using an isokinetic dynamometer. **Results:** In the bike condition, ROM ( $30.0 \pm 5.9 - 33.2 \pm 7.0$  degrees,  $p < 0.01$ ), passive torque at ROM maximum ( $28.6 \pm 7.1 - 33.7 \pm 8.0$  Nm,  $p < 0.01$ ), and peak torque ( $106.4 \pm 36 - 113.7 \pm 38.7$  Nm,  $p < 0.05$ ) increased; however, MTU stiffness was not different ( $0.56 \pm 0.33 - 0.48 \pm 0.11$  Nm/deg,  $p = 0.34$ ). In the hot condition, ROM ( $31.4 \pm 6.3 - 33.9 \pm 6.3$  degrees,  $p < 0.01$ ) and passive torque at ROM maximum ( $29.7 \pm 6.7 - 33.3 \pm 6.5$  Nm,  $p < 0.01$ ) increased; however, MTU stiffness ( $0.46 \pm 0.10 - 0.48 \pm 0.18$  Nm/deg,  $p = 0.62$ ) and peak torque ( $101.4 \pm 42.4 - 105.9 \pm 38.3$  Nm,  $p = 0.34$ ) were not different. In MVC condition, ROM ( $28.2 \pm 6.1 - 33.9 \pm 6.3$  degrees,  $p < 0.01$ ) and passive torque at ROM maximum ( $26.8 \pm 5.7 - 32.6 \pm 5.9$  Nm,  $p < 0.01$ ) increased; however, MTU stiffness ( $0.53 \pm 0.18 - 0.48 \pm 0.11$  Nm/deg,  $p = 0.88$ ) and peak torque ( $104.9 \pm 37.8 - 95.4 \pm 35.5$  Nm,  $p = 0.25$ ) were not different. **Conclusions:** The results indicated that all the warm-up programs increased ROM through an increase in tolerance. Aerobic exercise is better for the muscle strength. **References:** Taylor WF, et al. Cutaneous vascular responses to isometric handgrip exercise. *J Appl Physiol*, 66: 1586-1592, 1988. Sawyer PC, et al. Effects of moist heat on hamstring flexibility and muscle temperature. *J Strength Cond Res*, 17(2): 285-90, 2003. Contact: takeuchi-k@bss.ac.jp

## THE EFFECT OF COOLING ON MUSCLE WEAKNESS AND MUSCLE ATROPHY CAUSED BY DETRAINING

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**Introduction** Two weeks of detraining produces 6.4% of muscle atrophy even after long term strength training. Thus, to maintain the training effect, preventing the muscle weakness and muscle atrophy caused by detraining would be valuable. Exposure to cold stimulus by cold water inhibits muscular atrophy. The purpose of this study was to investigate the effect of cooling by ice bag on muscle weakness and muscle atrophy caused by detraining. **Methods** Six healthy males ( $23.0 \pm 2.5$  y/o) performed elbow flexion resistance training three times per week for 6 weeks. After the 6 weeks training, the subjects were instructed to limit upper arm activity within their activity of daily living level during three weeks of detraining period. During the detraining period, one of the arms was cooled at inside of upper arm by an ice bag for 30min a day (ICE), and the other arms was control condition (CON). The measurements were elbow flexion torques at angular speeds of 60 and 120deg/s under concentric contraction (CC60, CC120) and isometric contraction (IM), cross-sectional area (CSA) and circumference of the upper arm. The measurements were done, at pre-training (PRE), post-training (POST), after the first week (D1), second week (D2) and third week (D3) of detraining. **Results** IM significantly increased after training in both conditions (CON:  $118.0 \pm 13.6\%$ , ICE:  $112.5 \pm 2.4\%$ ) ( $p < 0.05$ ). Significant decreases of IM in CON was observed at D2 ( $66.6 \pm 17.4\%$ ) compared to POST ( $78.8 \pm 24.8\%$ ) ( $p < 0.05$ ). Circumference significantly increased after training in both conditions (CON:  $102.1 \pm 1.0\%$ , ICE:  $101.4 \pm 0.7\%$ ) ( $p < 0.05$ ). Significant decreases of circumference in CON was observed at D3 ( $29.6 \pm 3.4\%$ ) compared to D2 ( $29.8 \pm 3.5\%$ ) ( $p < 0.05$ ). CSA significantly increased after training in both conditions (CON:  $108.5 \pm 3.3\%$ , ICE:  $107.9 \pm 2.2\%$ ) ( $p < 0.05$ ). CSA significantly decreased after the detraining in both conditions. However, there was no significant difference in all of measurements between CON and ICE. **Discussion** Elbow flexion resistance training three times per week for 6 weeks increased the muscle force, circumference and CSA of the upper arm. Only IM increased after the training. It may be because of the fact that the training was composed of isometric contraction. Even though increased the muscle force, circumference and CSA by the training decreased by the detraining. The values at D3 were higher than the values at PRE. Consequently, the training effects were maintained. On the other hand, there was no decrease in IM and circumference in ICE during detraining period. This result suggests the possibility that the cooling prevents muscle weakness and muscle atrophy; however, there was no significant difference between both conditions, therefore we consider that the effect of cooling was weak. **In conclusion**, the cooling for 30min a day shows possibility that the cooling prevents muscle weakness and muscle atrophy caused by detraining. Contact ohanaforever07@gmail.com

## EFFECTS OF LOW-INTENSITY PULSED ULTRASOUND EXPOSURE ON SKELETAL MUSCLE REGENERATION AFTER DAMAGE IN AGED MOUSE MODEL

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**INTRODUCTION** Skeletal muscle regeneration is markedly impaired with age. Because protein synthesis decreases with age, satellite cell (muscle stem cell) numbers and their proliferative potential also decrease with aging. Low-intensity pulsed ultrasound (LIPUS) is a therapeutic modality commonly used for enhancing tissue healing. Previous studies have demonstrated that LIPUS increases activated satellite cells and promotes muscle regeneration in injured muscles (Nagata K, et al. 2013). Therefore, we hypothesize that LIPUS may provide a beneficial effect in injured aged skeletal muscle. This study examined the effects of LIPUS exposure on the regenerative process in injured aged muscle using histological analysis. **METHODS** Ninety-week-old female ICR mice (N=5) were used in this study. To induce muscle injury, cardiotoxin was injected into both sides of the tibialis anterior (TA) muscle. LIPUS, which was initiated 24 hours after injury, was applied to the left TA muscles (LIPUS side). LIPUS was applied once a day under the following conditions: 10 min/day, frequency of 3 MHz, intensity of  $0.5\text{W}/\text{cm}^2$ , 50% duty cycle. The right TA muscles (control side) received a sham maneuver where only the transducer was moved. TA muscles were excised 7 days after injury. Frozen cross sections of excised TA muscles were made. Sections were stained using hematoxylin and eosin, and sections were reacted with anti-desmin antibody (a myogenic cell marker). The fiber cross sectional area (FCSA) of centrally nucleated muscle fibers was measured. **Results** were analyzed using the paired t-test with statistical significance set at  $p < 0.05$ . **RESULTS** The regenerating muscle fibers with central nuclei were observed in the injured area. Mononuclear cells had

infiltrated the interstitium in both the control side and LIPUS side. FCSA of regenerating fiber varied in size from small to large. The mean FCSA of the control and LIPUS side was  $519.6 \pm 178.9 \mu\text{m}^2$  and  $598.5 \pm 200.0 \mu\text{m}^2$ , respectively. There was no significant difference between the control side and the LIPUS side. Regarding the size distribution of FCSA, it tended to differ between the control side and LIPUS side. In the control side, the number of myofibers with FCSA  $< 200 \mu\text{m}^2$  was larger compared with the LIPUS side. DISCUSSION In this experiment, the mean of FCSA was similar in both the control side and LIPUS side. However, the number of smaller myofibers tended to increase on the control side compared with the LIPUS side. Thus, exposure with LIPUS seems to have a beneficial effect on injured aged muscle. REFERENCES Nagata K, et al. (2013). *Ann Biomed Eng* 41, 1095-1105.

## DO SESSIONS OF WHOLE-BODY CRYOSTIMULATION HAVE INFLUENCE ON RHEOLOGICAL PROPERTIES OF BLOOD IN HEALTHY MEN ?

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**Introduction** The rheological properties of blood are very important for the proper functioning of the body. The present research of rheology is blood viscosity. Blood viscosity within the given shear stress depends on the value of hematocrit, plasma viscosity and the rheological properties of erythrocytes. The rheological properties of blood change in different situations, both physiological (physical exercise, the last trimester of pregnancy, the time of year) and pathological conditions, such as. inflammation or cardiovascular disease. **Objective** The aim of this study was to analyze the changes in rheological parameters of blood after 12 whole body cryotherapy (WBC) treatments. **Methods** The study was carried out on 8 healthy men aged  $22 \pm 2.1$  years old. The mean body height was  $175.5 \pm 3.16$  cm, body mass was  $70.4 \pm 10.3$  kg, BMI  $22.8 \pm 2.8$  kg/m<sup>2</sup>. To analyse the morphological, (hemoglobin, hematocrit, fibrynogen) and rheological properties (aggregation index, the amplitude and total extent of aggregation, the half time of the aggregation, deformability of RBC ) of blood, the blood was sampled immediately before the first treatment (control blood sample) and after 12 WBC treatments. Twelve WBC treatments (every second day, for 1 months) were performed in a special cryogenic chamber at the temperature of about  $-120^\circ\text{C}$  for 3 minutes in the Matopolskie Centrum Krioterapii in Krakow, Poland. **Results** After 12 WBC treatments there was not any changes in the rheological properties of blood. There was recorded a statistically significant decrease in hemoglobin but without changes in hematocrit. All results were within the physiological norms. **Conclusions** 1. WBC is the safe treatment for health people, does not cause changes in blood flow. 2. 12 sessions of whole body cryostimulation causes small changes in the blood parameters. 3. The results of this research should be validated in a larger study group. The project was financed from the funds of the National Science Centre in Krakow, Poland on the basis of a decision no. DEC-2012/05/N/NZ7/01107. Contact m.kepinska@tlen.pl

## Sociology

### RESEARCH ON THE ORDER OF TAE KWON DO : POPULARIZATION AND ATHLETICISM

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From understanding the concept of sports order and its process including spontaneity, self-consciousness, heteronomy, autonomously, self-discipline to analyze the order of Tae Kwon Do as sport. This article aims to discover the fact that the order of Tae Kwon Do in the development of Popularization and Athleticism has its process as well as others sports . Tae Kwon Do can be developed Vigorously only follow this process and take advantage of its principle and requirement. The spontaneity and self-consciousness of Tae Kwon Do should be respected in its development of Popularization, while the heteronomy should be complied with its mightiness of Athleticism. The order of Tae Kwon Do would be run in the society after the unity of Popularization and Athleticism operation cause of autonomously and self-discipline be in motion.

### THE USE OF PERFORMANCE-ENHANCING SUBSTANCES AMONG MEDICAL STUDENTS OF A MIDDLE EASTERN UNIVERSITY

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**Introduction** The use of performance-enhancing substances (PESs) can be extremely dangerous. Multiple data among college students exist in the literature (Buckman et al., 2009; McCabe et al., 2007). However, it could be interesting to describe this phenomenon among medical students, future health promoters. The aim of this study was to determine the prevalence of PESs use and identify the factors associated with this behaviour among medical students of a Lebanese university. **Methods** A cross-sectional survey using an anonymous structured self-administered questionnaire was conducted between January and March 2013 among 579 students at a major Lebanese school of medicine. PESs users were defined as students who reported use of PESs (including prohibited substances and nutritional supplements) within the past year. **Results** A total of 505 valid responses were obtained (response rate: 87.2%). More than half of the respondents (58.6%) stated they participate in sports once or more per week, and 18 (3.6%) reported past-year use of a PES. There were statistically significant associations between the use of PESs and being male (-p-value=0.001), cigarette smoking (-p-value<0.0001), regular alcohol consumption (p-value=0.018), practicing sports more than once a week (-p-value=0.013), practicing strength (-p-value=0.032) and team sports (-p-value=0.019), participating in national (-p-value=0.018) and regional competitions (-p-value=0.010), and receiving an award following a sport competition (-p-value=0.014). Nutritional supplements and proteins were the most PESs used, followed by ephedrine and anabolic steroids. **Discussion** Fortunately, the use of PESs is not prevalent in our population despite the fact that the majority of participants are sporty. It is probably due to the future role of medical students as actors in the field of anti-doping activity. However, the PESs use by our students fits the standard profile of substance use (Buckman et al., 2009; McCabe et al., 2007) because it was associated with other risky behaviours such as smoking and alcohol consumption. It is also associated with frequent sport practices, which exposes the fact that PESs use is an important area of concern for athletes (Morente-Sánchez et al., 2013). Since our survey was conducted among medical students, more researches on the use of PESs in athletes (elite and amateur) are needed. The factors associated with PESs use may have important implications for future studies and preventive measures. **References** Buckman JF, Yusko DA, White HR, Pandina RJ. (2009). *J Stud Alcohol Drugs*, 70(6), 919-923. McCabe SE, Brower KJ, West BT, Nelson TF, Wechsler H. (2007). *Drug Alcohol Depend*, 90, 243-251. Morente-Sánchez J, Zabala M. (2013). *Sports Med*, 43(6), 395-411.

## THE RELATIONSHIP BETWEEN CHILDREN'S OPTIMISTIC CHARACTERISTIC AND SPORT ENJOYMENT

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**Introduction** Physical activities are beneficial to the development of body and mind in children. Therefore, it is important to discover relative factors that enhance youngsters to participate in physical activity. In particular, sport enjoyment is one indicator of long-term adherence to physical activity. Further, personality trait is considered as a crucial factor that may influence children's participation motivation of physical activity (Schneider & Graham, 2009). The purpose of this study was to investigate the relationship between children's optimistic personality and sport enjoyment. **Methods** One hundred and sixty-two 3rd grade to 6th grade elementary students (boy: 147, girl: 15, mean age: 10.12 ± years) who participated in after-school soccer and fitness programs were recruited to complete the Youth Life Orientation Scale and Physical Activity Enjoyment Scale. A Pearson's product moment correlation was used to analyse the data. **Results** Optimistic personality was found to positively relate to the four sub-scales of enjoyment, such as activity itself ( $r = .38$ ), social and life opportunities ( $r = .42$ ), praise and reward ( $r = .46$ ), and perceived competence ( $r = .38$ ). **Discussion** Individuals with optimistic characteristics tend to expect a positive result and keep a high level of confidence while facing challenges. Further, they are apt to stick to the enthusiasm and demonstrate persistence toward difficult events (Scanlan, Stein, & Ravizza, 1989). With such a positive psychological quality, an individual is relatively easy to feel positive emotions such as joy, happy, making new friends, competence and other sports enjoyment when participating in physical activity (Allen, Greenlees, & Jones, 2013). The finding suggests that physical education teachers or instructors are needed to pay attention to students' personality traits that may moderate the positive affect of participation in physical activity. **References** Allen, M. S., Greenlees, I., & Jones, M. V. (2013). *International Review of Sport and Exercise Psychology*, 6, 184–208. Ey, S., Hadley, W., Allen, D. N., Palmer, S., Klosky, J., Deptula, D., et al. (2005). *Journal of Child Psychology and Psychiatry*, 46, 548–558. Jun-Jie Tsai, & Hui-Jung Fu, (2012) *Journal of National Taichung University : Education* 26 (1), 123-141. Scanlan, T. K., Stein, G. L., & Ravizza, K. (1989). *Journal of Sport and Exercise Psychology*, 11(1), 65-83. Schneider M & Graham D, (2009). *Med Sci Sports Exerc*; 41: 947–55 Contact Leila0116@gmail.com

## EXERCISE PASSION, PERCEIVED RISK, AND BENEFITS OF RECREATIONAL SCUBA DIVERS

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**Introduction** The benefits of participation in leisure activity include relieving stress, enhancing life excitement, maintaining physical fitness, and promoting social relationships. Few studies have examined the influences of perceived leisure risk and exercise passion on leisure benefits of adventure leisure activities (Vallerand et al., 2003). The purpose of the study was to explore the relationships between exercise passion, perceived leisure risk, and leisure benefits in scuba diving participants. **Method** Two hundred scuba divers (age ranged from 20 to 60 years) were recruited to complete a battery of questionnaires regarding exercise passion, perceived leisure risk, and leisure benefits in a resting setting. Data obtained in this study were analyzed by correlated analyses and multiple regression analyses. **Results** Compared with the beginning divers, those who were certified divers indicated higher perceptions of diving risk and diving benefits. For the certified divers, harmonious and obsessive passion and perceived leisure risk could positively predict leisure benefits. For the beginning divers, harmonious passion and perceived leisure risk could positively predict leisure benefits, whereas obsessive passion was negatively related to leisure benefits. **Discussion** The certified divers revealed higher levels of harmonious passion, leisure risk and leisure benefits than the beginning divers. Similarly, previous research has showed that harmonious and obsessive passion of recreational tennis players positively correlated with long-term exercise adherence (Vallerand & Miquelon, 2007). Further, those participants who demonstrated a higher level of involvement in leisure were apt to perceive a larger amount of leisure benefits (Vallerand et al., 2003). For adventure leisure participants, they might consider activity-related risks as a part of adventures that would not reduce the interests or values of involvement in such activities (Dowling & Staelin, 1994). The findings indicate that individuals may perceive larger benefits in physiological, psychological, and social aspects when they gain greater knowledge of diving risk. Diving experience seems to be a moderator between exercise passion and leisure benefits. **References** Dowling, G. R., & Staelin, R. (1994). *Journal of Consumer Research*, 21(1), 119-134. Priest, S., & Baillie, R. (1987). *Journal of Experiential Education*, 10(1), 16-22. Vallerand, R. J., & Miquelon, P. (2007). In D. Lavallee & S. Jowett (Eds.), *Social psychology in sport* (pp. 249-262): Champaign, IL: Human Kinetics. Vallerand, R. J., Blanchard, C., Mageau, G. A., Koestner, R., Ratelle, C., Leonard, M., & Gagne, M. (2003). *Journal of Personality and Social Psychology*, 85, 756-767. Contact waterpolo0128@gmail.com

## THE INFLUENCES OF PSYCHOLOGICAL NEEDS AND EXPECTANCY VALUE ON LEARNING MOTIVATION IN PHYSICAL EDUCATION CLASS OF MIDDLE SCHOOL STUDENTS

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**Introduction** A close relationship has been found between students' involvement in physical education and their learning motivation. Previous study showed that learning motivation of middle school student was effected by the levels of self-determination (Deci & Ryan, 2002). Further, based on the expectancy-value theory (Eccles et al., 1983), expectancies and values are assumed to influence directly performance, effort, and persistence. Fewer studies have simultaneously discussed the influences of self-determined motivation and expectancy values on learning motivation. The purpose of the study was to investigate whether students' psychological needs satisfaction and expectancy values may affect learning motivation in physical education class. **Methods** This study recruited 451 junior high school students (age = 14.21 years) as the participants from Taipei city. Participants completed the Basic Psychological Needs Scale, Learning Motivation in PE Scale, and the Sport Expectancy Value Scale. The data were processed by descriptive statistics and independent t-tests. **Results** The results indicated that the students with higher perceptions of relatedness, autonomy, and competence demonstrated higher learning motivation than those with lower perceptions of basic psychological needs. Besides, the students who reported higher task value exhibited higher learning motivation than those who reported lower task value. **Discussion** The findings indicated that basic psychological needs satisfaction and expectancy values could significantly influence students' learning motivation in PE. Perceived relatedness was the most important factor affecting learning motivation, which is presumably related to the needs of belonging and identity by peers in adolescents (Deci & Ryan, 2002). Consistent with the prediction of the expectancy-value theory (Eccles & Wigfield, 2002), a higher level of perceived task value would enhance intrinsic motivation in PE class. PE teachers and instructors might facilitate the learning motivation of students by satisfying their basic psychological needs and enhancing their value perceptions of participating in PE class. **References** Edward Deci, & Richard M. Ryan (2002). *Handbook of self-determination research*. Rochester, N Y: University of Rochester

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### **A QUALITATIVE ANALYSIS OF THE OPINIONS OF ATHELETES, COACHES AND ANALYSTS ON THE PROVISION OF FEEDBACK IN ELITE AND SUB-ELITE SPORT.**

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Introduction Qualitative research is classified as a broad interpretive or hermeneutic tradition in social science and the humanities (Taylor, 1979; Messer et al., 1988), such information seeks to understand the meaning of an experience to the participants in a specific setting (Thomas et al., 2005). Since the advances in technology aiding the reliability of feedback, a qualitative study has not been instigated to investigate the roles of the coach and opinions of the athletes with respect to feedback procedures. Limited research (Murray et al., 1998) has been conducted investigating the psychological states of athletes, but athlete opinions were omitted from the investigation. Methods By formulating three individual questionnaire and interview guides, athletes, coaches and analysts were enquired about feedback, in the event to confirm the value of performance analysis strategies and suggest any further quantitative techniques. Following a detailed pilot study, data were collected from 93 athletes and nine coaches and nine analysts. Results Results indicated that verbal instruction was the athletes most preferred method to receive feedback, in addition to all coaches predominately using this method. 98.91% of athletes find video feedback beneficial, with analysts insisting, that video feedback is the most effective way to convey a message to team/individual. Athletes addressed that statistical feedback alone does not hold the same significance as video instruction, yet when combined an effective feedback measure is produced. All coaches (100%) take advantage of time following performance, by providing feedback through verbal, statistical and video measures. Elite analysts, conduct analysis in-event or directly after, providing immediate feedback and allowing coaches to interpret results prior to presenting to athletes. This improving the quality of feedback, as an overload of information is not presented. Statistical, verbal and video feedback are used within a training environment, seizing the advantage of time available to transfer information. Discussion Results strongly confirmed the value of performance analysis techniques when only 5.00% of athletes did not find analysing their own performance in post-event beneficial. References Messer, S.B., Sass, L.A. and Woolfolk, R.L. (1988). *Hermeneutics and psychological theory: Interpretive perspectives on personality, psychotherapy, and psychopathology*. New Brunswick: Rutgers University Press. Maynard, I. Hughes, M. and Reilly, T. (Eds.) *Science and Racket Sports II*, pp. 235-240. London: E. & F.N. Spon. Taylor, C. (1979). *Interpretation and the science of man*. In Rabinow, P. and Sullivan, W. (Eds.). *Interpretive Social Science: a Reader*. Berkeley CA: University of California Press. Thomas, J.R., Nelson, J.K. and Silvermann, S.J. (2005). *Research Methods in Physical Activity* (5th Ed). Champaign Illinois: Human Kinetics Publishers. Contact dancs@mnsk.nyme.hu

### **Sport Management and law**

#### **DRAFTING A PROPOSED POLICY LEGISLATIVE WOMEN AND SPORT IN KUWAIT**

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Witness sports movement great attention and sensation of the relationship correlation between sport, legislation, specifically between sport and legislative policy based on the principle of a stable legal emphasizes the correlation of law in all walks of human life, economic, political and sports as well, and some believe that the laws and legislation is not suitable for field sports, and it is far from sports practice However, within the framework of regulations for games such as football, basketball, volleyball, etc. and 00 but became the subject is important and vital for the management of sports and action sports practice and influential but also in production in many developed countries. The legislative policy is the goal of the legislation relevant to the promulgation and application of public policy senior, in varied Bmajaladtha in various aspects of political, social, economic, and enacted through legislation. Public policy is difficult to impose, and is applied through legislation is characterized by a set of legal rules from the application of these characteristics make the policy binding. Discipline is achieved for each game through legislation and laws as they are in compliance with international law of the game and the referees are judges who implement the law as it is an important component of the evolution of the sport movement. Sued the governance of a particular kind is issued judgments immediate and decisive as that at the same time, the executive authority of any decision he takes, and working on its implementation What we are dealing with in this context is to develop a vision of philosophy for the formulation of a proposed reality of women's sports in the State of Kuwait and that as part of work leadership and management in sports organizations where you need to participate in the formulation of public policy upon the parties to the first party of government decision-maker which is based on ensuring the safety of the implementation of decisions and the second community He is represented in this context (science and scientists) as an important basis to participate in the formulation and elaboration of this policy where adopt the experience of countries that apply the reform programs, all aspects of human life as this reform for Nokia moving right only if the voice of civil society, scientists heard through participation in the formulation of policy both in his speciality.

#### **COMPARE AND RELATIONSHIP BETWEEN ORGANIZATIONAL CULTURE AND HUMAN RESOURCE PRODUCTIVITY IN PHYSICAL EDUCATION ORGANIZATION OF THE ISLAMIC REPUBLIC OF IRAN FROM THE VIEWPOINTS OF MANAGERS AND EXPERTS**

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Introduction Achieving productivity is one of the main goals of any organization. To achieve this goal, there is no other way except resorting to some kind of systematic, native, and practical perspectives. Methods From among 1600 general manager, based on Morgan sampling table, we chose 310 managers and experts from the Physical Education Organization of the Islamic Republic of Iran who is working across the country. Data were collected from three demographic questionnaires with eight questions, Robbins' organizational culture questionnaire with 30 questions, and productivity questionnaire with 26 questions. Then, the data were analyzed using descrip-

five statistics including measures such as frequency, mean, standard deviation and inferential statistical techniques in addition to tests such as Cronbach alpha test of Levin, the Kolmogorov-Smirnov test, t-test and u Mann-Whitney. Results The analysis of finding is shown that have meaning full relationship between organizational culture with efficiency of managers and experts. The relationship between individual's characteristic such as age, Education unseem with organizational culture and efficiency. But was seen the negative meaningful ( $P=0/021$ ,  $r=136$ ) relationship between information work with organizational culture and the positive meaningful ( $P<0/699$ ,  $r=0/023$ ) relationship with efficiency. Discussion Therefore, if there is a necessity to improve the elements of organizational culture, productivity of employees needs to be increased or vice versa. Since, in this study, most elements of organizational culture and productivity of employees were at average level, it is suggested to take appropriate measures to improve the current organizational culture in the Physical Education Organization of Iran. Such measures should include providing an appropriate and desirable environment for inventive and creative individuals along with awareness-raising through continuous on-job training by experts. In this way, it is hoped to improve organizational culture and have greater productivity in the future. References 1. Andreassi, J. K., Lawter, L., Brockerhoff, M., Rutigliano, P. J. (2014). Cultural impact of human resource practices on job satisfaction: A global study across 48 countries. *Cross Cultural Management: An International Journal*, 21(1):4. 2. Ghorbani, M.H., Asadi, H., Godarzi, M., Shafiei, M. (2009). The Study of Organizational Culture of Physical Education Organization of Islamic Republic of Iran Based on Denison's Model and Comparing It with World Averages. *Harakat*, 39(33):4. [Article in Farsi] 3. Gregory, B., Harris, S., Armenakis, A., Shook, C. (2009). Organizational culture and effectiveness: A study of values, attitudes, and organizational outcomes: *Journal of Business Research*, 62(7), 673-679. 4. Macintosh, E.W., Doherty, A. (2010). The influence of organizational culture on job satisfaction and intention to leave. *Sport Management Review*, 13(2):106-17.

## Sport Statistics and Analyses

### RELATIONSHIP BETWEEN BALL SPEED OF SPIKE IN VOLLEYBALL AND TRUNK STRENGTH

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**PURPOSE :** The spike in volleyball is one of the effective ways to score. Increasing the spike speed increases chance to score. Yoshihara et al. (2009) reported, 1) plyometrics with exercise ball is the effective training to increase the spike speed, and 2) condition of increasing the spike speed is requires balance in the air and the fast start of arm and trunk motion. We conclude it requires measuring trunk strength, but Yoshihara et al. didn't reported. So, the purpose of this study is to identify relationship of the spike speed with trunk strength and with balance. **METHODS :** Research participants were 16 hitters of C university men's volleyball team, their height, weight, age, and volleyball career (average $\pm$ SD) were 1.80 $\pm$ 0.04 m, 73.3 $\pm$ 1 kg, 20.3 $\pm$ 0.9 years old, 9.6 $\pm$ 1.9 years. Measurements were the spike speed calculated by radar speed gun, strength of trunk flexion and extension by BIODEX, and throwing medicine ball test with 3kg and 5kg in following positions; standing, standing on knees, sitting on an exercise ball, and standing on balance discs. Correlation coefficient was calculated the spike speed and each measurement. Pearson's correlation coefficient was used ( $p<0.05$ ). **RESULTS :** In throwing medicine ball test, throwing distance performed on exercise ball and balance disc both with 3kg and 5kg were significantly correlated with the spike speed. Throwing distance in standing on the floor with 3kg was significantly correlated with spike speed. Throwing in knee-standing was not significantly correlated with the spike speed. In BIODEX measurement, trunk flexion strength was significantly correlated with the spike speed. **CONCLUSION:** Yoshihara et al. (2009) reported to increase the spike speed, the high performance of trunk in the air was needed. In this study, we found throwing performance on exercise ball and on balance disc related the spike speed. These positions are more unstable than standing on a floor. To increasing the performance under unstable conditions will enhance performance in the air, therefore, increase the high performance of the spike speed. Yoshimatsu et al. (2006) reported, in spike, swing is produced by trunk flexion and twist. We also found strength of trunk, especially flexion strength related the spike speed. Then the trunk performance in unstable condition and trunk flexion strength will increase the spike speed.

### REASONS FOR SPORTS PARTICIPATION AMONG JAPANESE HIGH SCHOOL STUDENTS: DIFFERENCES BETWEEN SPORTS CLUB MEMBERS AND NON-SPORTS CLUB MEMBERS

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**Purpose** People play sports because they are fun (Sugihara, 2000). However, the structure of the joy felt while playing sports is complicated and not yet fully understood (Wada, 2000). This study aimed to investigate differences in the reasons for participating in sports among Japanese high school students who regularly participate in sports and those who do not. **Methods** A questionnaire survey was conducted of 738 high school students (386 sports club members and 352 non-sports club members) at two high schools in Japan. Questionnaire items were taken from Han et al.'s questionnaire on the motivation for participating in sports (2014), which was translated from Korean to Japanese. All questionnaire responses were rated on a 5-point Likert scale. Factor analysis was conducted and the factorial structure was extracted. For factor analysis, extracted factors with eigenvalues greater than 1.0 were rotated using Varimax orthogonal rotation. Factor scores were also computed with regression analysis. The students were categorized as either sports club members or non-sports club members and t-tests were conducted to compare the two groups. **Results** Three factors were extracted as a result of factor analysis. Since the first factor had significant factor loadings in items that effectively use the students' time to improve their motor skills or physical fitness, we interpreted this factor as the "improving physical fitness or motor skills" factor. The second factor was interpreted as the "showing off sports/exercise performance" factor because it had significant loadings in items relating to boasting about motor skills or exercise performance. We also found significant loadings in items for making friends or getting along with friends in the third factor, which we interpreted as the "sociability" factor. **Statistical comparison** of the three factor scores between sports club members and non-sports club members indicated that a significant difference was found in the first and third factors, and that sports club members had a positive opinion of sports. **Conclusion** Sports club members regularly played sports or exercised and sufficiently understood the effects of such activities, such as improved physical fitness or motor skills. Many non-sports club members played sports or exercised in their spare time because they did not have other activities to participate in. In addition, we found two factors related to motivation to participate in sports/exercise; individual factors and social factors. The former was the individual reasoning to improve individual abilities (e.g. physical fitness or motor skills), and the latter was the social reasoning to maintain or advance friendships. However, no sports club members played sports or exercised in order to show off their motor performance or skills.

## 5SD BODY BUILD CLASSIFICATION OF 13–15-YEAR-OLD MALE VOLLEYBALLERS FOR COMPARATIVE ASSESSMENT OF THEIR SPIKING PERFORMANCE DURING THE ESTONIAN CHAMPIONSHIPS IN 2014

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**Introduction** We somatotyped 13–15-year-old volleyballers into a 5 SD height-weight classification according to concordance or discordance between their height and weight. As a number of earlier researchers have found that anthropometric characteristics influence the competition results in different sports, we tried to find if there is a relationship between body type and spiking efficiency. **Methods** The subjects of the study were 63 male volleyballers who participated in the Estonian Championship in 2014. During 28 matches, each boy's spiking performance was recorded by the computer program Game. Thirteen body measurements were taken: height, weight, suprasternal height, xiphoidal height; chest, waist, hip, wrist, upper thigh and lower leg circumferences, arm circumference flexed and tensed, and wrist breadth. We applied a classification that was based on the boys' mean height and weight and the respective standard deviations. The following classes were created: (1) small – small height and small weight; (2) medium – medium height and medium weight; (3) big – big height and big weight; (4) pycnomorphs – small height and big weight; (5) leptomorphs – big height and small weight. The boys were placed into the classes according to their individual heights and weights. The boys' spiking performance in the games of the whole tournament was assessed in the same 5 SD classes into which they had been systematized according to their anthropometric measurements. **Results** Statistical differences appeared between the classes of pycnomorphs and leptomorphs. Leptomorphs were statistically significantly better in the total numbers of spike, average number of spikes per game, total of number of successful spikes, average number of successful spikes per game. The total number of spikes for the class of leptomorphs was 77.6 and for pycnomorphs 21.2 on average. The classes of small, medium and large did not statistically differ from one another, but in all cases, the large class was better than the medium, and the medium class was better than the small class. The index of proficiency during spike was 0.25 in the large class, 0.14 in the medium class and 0.11 in the small class. **In conclusion**, the boys of the large class were the most successful. **Discussion** The 5 SD classification applied by us enabled us to systematize simultaneously the anthropometric variables and performance results. The classification has been acknowledged in C. Raschka's monograph *Sportantropologie* (2006) as an innovative Estonian system of sports and constitutional typology. **References** 1.Raschka C. *Sportantropologie*. Köln: Sportverlag Strauss, 2006, 219–220.

## INJURIES IN GERMAN CLUB SPORTS –EPIDEMIOLOGY AND FIELDS OF PREVENTION

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**Introduction:** Almost one out of four Germans is registered in a sports club. Nowadays, sport is acknowledged as an integral component of a healthy lifestyle. Numerous studies provide evidence of the benefits of sports on health. However, about 2 million sports injuries per year diminish the health benefits of sport. On the basis of epidemiological data of sports injuries in German sports club it is aimed to identify focal areas for the development and implementation of prevention measures. **Methods:** Continuous questionnaire-based injury monitoring on club sports injuries that have been reported to the respective sports insurance. Full survey among selected federal sports associations. **Results:** Since 1987 a database of more than 200,000 sports injuries has been established. 75% of the injuries are registered in football, handball, basketball and volleyball, although only 30% of all sports club members are organized in these sports. Ankle injuries have decreased from 30% to 19%, whereas the rate of knee injuries has increased slightly from 17% to 21%. Days of disability have dropped steadily since the 1990s, whereas inpatient hospital days have doubled from 5 to 10 days. The share of injuries that need surgery increased from 30% to 40%. Injuries to the knee, lower leg and upper arm have the highest surgery rate, indicating more serious injuries here. **Discussion:** The presented injury figures raise the question of how an active lifestyle can be promoted while reducing the 'side effects' of sport – i.e. sports injuries – to the lowest possible level. To maximize the reach of preventive measures, the focus should firstly be on sports with a large number of active participants and high absolute number of injuries, or a relevant level of serious or fatal injuries, leading to team ball sports are a major area of focus for injury prevention. Moreover, prevention measures should be tailored to those body regions that are most commonly and severely affected. While the prevention of ankle injuries seems to be headed in the right direction, especially the proportions of knee injuries and head injuries are increasing. Prevention programs need to be adjusted to trends e.g. team ball sports becoming more popular among women, who are more prone to severe knee injuries. The fact that "bad luck" or "a series of unfortunate events" are still frequently quoted as main causes for sports injuries shows how essential information on injury causation and the existence of effective prevention measures is. Preventive measures can be found in the four "fields of prevention": "Training measures and athletic preparation", "technical and political measures", "equipment and facilities" and "medical and non-medical support". thomas.henke@rub.de

## FACTORS OF SUCCESS IN A TRIATHLON MIXED RELAY WORLD CHAMPIONSHIP RACE

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**Introduction** Recently, the triathlon competition system organised by the International Triathlon Union (ITU) has been modified and now consists of less standard distance and more sprint and super sprint races. In the 2014 ITU Mixed Relay World Championships in Hamburg all national teams consisted of four athletes (woman-man-woman-man). Each athlete had to race a super sprint triathlon of 300 m swimming, 6.600 m cycling and 1.600 m running. Until today, no mixed relay competition analysis has been published. The aim of the present analysis was to objectify performance and to identify the impact on the overall result. **Methods** 16 finishing teams were included into this study. To objectify performance, swimming and running distances were calculated using laser tracking (Laser 1200S, Nikon, Tokyo, Japan) and a measuring wheel (Rollfix Easy, BMI, Hersbruck, Germany), respectively. The length and power output of the bike leg was quantified using the German athletes' PowerMeters (SRM GmbH, Juelich, Germany). Official results were obtained from the online database of the ITU. Significant group differences between medallists (rank 1-3) and participants (rank 4-16) were detected using Mann-Whitney U-test. **Results** Swim velocities amounted to  $1.30 \pm 0.04$  m/s for females and  $1.44 \pm 0.05$  m/s for males. Female triathletes on third position were significantly faster in the medal winning teams ( $1.33 \pm 0.01$  m/s vs.  $1.28 \pm 0.04$  m/s;  $p < 0.05$ ). Females and males showed an average bike speed of  $37.3 \pm 0.9$  km/h resp.  $40.1 \pm 1.1$  km/h. Male medallists achieved significantly higher speeds than participants on the second and fourth position ( $41.3 \pm 0.2$  km/h vs.  $40.4 \pm 0.8$  km/h and  $41.2 \pm 0.4$  km/h vs.  $39.3 \pm 1.1$  km/h;  $p < 0.05$ ). Mean absolute and relative power output for position one, three and four in the German team were 211 W (4.2 W/kg), 209 W (4.1 W/kg) and 325 W (4.6 W/kg), respectively. Running speeds were  $4.91 \pm 0.17$  m/s for females and  $5.60 \pm 0.23$  m/s for males. Significant differ-



ences were found between male medallists and participants on the last leg ( $5.98 \pm 0.13$  m/s vs.  $5.57 \pm 0.26$  m/s;  $p < 0.01$ ). Discussion In comparison to individual triathlons, the swim and bike parts have an increased impact on the competition result. Swim velocities and power outputs were higher than in other analysed ITU World Triathlon Series sprint and standard distance races whereas running speeds were almost identical (unpublished data). Cycling has a higher influence as bike groups are smaller and the possibility for drafting is reduced. Because the mixed relay might be added to the program of the 2020 Olympic Games, there is an increasing need to understand the factors determining success in this event. Acknowledgements This study was supported by a grant from the German Federal Ministry of the Interior. Contact poeller@iat.uni-leipzig.de

### WHAT DO RHYTHMIC GYMNASTICS JUDGES THINK ABOUT THEIR CODE OF POINTS?

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Introduction The Code of Points (COP) is an evaluation tool but that contribute also to the evolution of Rhythmic Gymnastics (RG) as sport. This tool is applied in competition by the judges giving them a very important role in this process. So it becomes very important to know the RG judges that apply this tool in the main competitions (the international level RG judges) and their opinion about de COP. The main role of this study was to characterize the international level judges and their perception of the objectivity level of their judgment in competitions. Methods 160 international RG judges answered a survey to collect the data. The survey was composed by 15 questions grouped in 2 categories: (1) personal information, education, professional experience and experience as judge, and (2) objectivity of evaluation in RG and proposals to change the COP.(FIG,2012) For the data analysis, non-parametric tests were used. Results The judges were  $43 \pm$  years old (min 22 - max 68 years old), 49% have a university degree, 87% are also coaches and all of them are judges for more than 2 Olympic cycles. For the judges, the Difficulty evaluation has more subjectivity for the difficulty elements of Mastery and Dance Steps and less subjectivity in the difficulty elements of Balance. Concerning the Execution, the judges found that the evaluation of the Artistic faults is the most subjective in this domain. Inside the Artistic faults the parameters Unity of the Composition and Relation between the music and the movements, were those who registered higher significant results for the subjectivity in the evaluation. Discussion This evidence might be related to the fact that the validating criteria for the elements are, probably not enough specific, what can cause some pliability in the evaluation, as well as some definitions such as refer Simões (2000) which states that any evaluation system should hold precise criteria for judging performance. The judges proposed changes in the COP regarding evaluation criteria of the following difficulty groups: Mastery, Dance Steps and DER. Also they found that changes must be done to make the Artistic faults, more precise. Finally the judges referred their wish to have some rule to avoid the repetition of the same difficulty elements on the routines with the different apparatus. This result can contribute to an improvement of the COP and in consequence to help in the development of this sport. References FIG. (2012). Code of Points for Rhythmic Gymnastics Competitions. from <http://www.fig-gymnastics.com/site/page/view?id=472> Simões, G. (2000). A avaliação do desempenho Docente. Lisboa: Texto Editora. Contact catarinaleandro@sapo.pt

### ANALYSIS OF INTERACTION BETWEEN OFFENSE AND DEFENCE TACTICS IN TEAM HANDBALL BY MEANS OF ARTIFICIAL NEURAL NETWORKS

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Introduction In team handball performance indicator analysis of single actions provides a general view about playing trends and can reveal valuable information about the strength and weak points of teams (Meletakos et al., 2011). However, the focus on single action analysis only gives restricted insight into tactics and does not take into account team interaction. Therefore, the aim of this study is to propose a method to analyze action sequences and team interaction in handball by means of artificial neural networks (ANN) to obtain a deeper understanding of the tactical performance. Methods Twelve games from the EHF EURO Men 18 in Hard (Austria) were captured by 8 cameras. Ground positions of offensive and defensive teams were determined with custom-made software. In total, 723 offensive actions and defensive situations were recorded. Subsequently, offensive and defensive data were analyzed separately with ANN software (Perl, 2002) to determine tactical patterns. Each neuron of the trained ANN represents a pattern of offensive or defensive actions, respectively. Neighboring neurons which are grouped to clusters represent similar offense or defense behavior. In a next step the related offensive and defensive behaviors were further analyzed. In order to compare the success of different defensive behaviors odds ratios were calculated. Results The ANN determined 25 offensive and 14 defensive clusters (i.e. behaviors). We observed that different defensive behaviors with different chances of success were used against specific offensive behaviors. As an example, nine different defensive behaviors were used against offensive behavior cluster #1. However, odd ratio analysis revealed that defensive behavior #3 was 2.8 times more successful than defensive behavior #5. On the other hand we observed that e.g. defensive behavior #1 was more successful (by 1.7 times) against offensive behavior #1 compared to offensive behavior #16. Discussion The results showed the applicability of ANN for identifying offense and defense patterns in team handball which could then be used for the analysis of interaction. Odds ratio analysis allowed estimating the chance of success of different defensive tactics against a specific offensive tactics and vice versa. The proposed method augments tactical analysis for coaches and can support them in the development of offensive and defensive tactics in game preparation. References Meletakos P, Vagenas G, Bayiso I (2011). Int J Perform Anal Sport, 11, 284-294. Perl J (2002). Int J Perform Anal Sport, 2, 21-35.

### COUNTERATTACK IN TEAM HANDBALL: ANALYSIS AND COMPARISON OF WINNERS AND LOSERS OF EHF CHAMPIONS LEAGUE 2013/2014 FINALISTS

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Do not insert authors hereIntroduction Team sports, like handball, are divided in different phases (offensive, defensive and transitions) depending on the ball possession. The teams changes the way they play based on which stage they are, the game result or their strategies. During the offensive transition teams can use a strategy called counterattack to reach fastly the opponents goal and attack with their defense system unpositioned. The use of this strategy could determine significantly the game result and differentiate winners and losers of the game. Thus, coaches and their staffs can improve training sessions. The aim of this work were to investigate the counterattacks sequences of EHF Champions League 2013/2014 finals, to analyze the beginning, the end and the numerical ratio between the teams during the actions (comparing winner and losers). Methods Twelve matches of the EHF Champions League 2013/2014 finals, semi-finals

and quarter-finals were analyzed, through videos obtained of broadcasting public website. The counterattack sequences of these matches were analyzed and some variables proposed by Prudente et al. (2004) were quantified and adjusted. These adjustments led us to create a numerical ratio index, based on numeric differences between players of each team. After quantify this variables, winners (WG) and losers (LG) were compared to observe differences between these groups. Results In the beginning of the counterattacks, the reasons that most differentiate WG and LG was the goalkeepers saves (33% WG; 26% LG) and the output shots (11% WG; 6% LG). In the end of the counterattacks WG shows a better effectiveness in the counterattack actions (52,7%) than LG (47,8%). The numerical ratio shows that WG uses more frequently the counterattack strategy when they are in numerical inferiority, while LG uses it more when they are in numerical superiority. Discussion The comparison between WG and LG pointed out that WG had a better performance in goalkeepers effectiveness, output shots, counterattack effectiveness and more often use of counterattacks when they are in numerical inferiority than superiority. We conclude that those variables, including numerical inequalities, are important for a team which wants to use this strategy and they have to focus on this in their planning training sessions. References Pontes F. (1983). A eficácia no ataque. Um estudo estatístico sobre dois níveis de competição nacional. *Revista Setemetros*, 1(7), 32-34. Prudente J, Garganta J, Anguera MT. (2004). Desenho e validação de um sistema de observação no andebol. *Portuguese J Sports Sci*, 4(3), 49-65. Contact: [vinciusmusa11@gmail.com](mailto:vinciusmusa11@gmail.com) / [rafaelpombo@usp.br](mailto:rafaelpombo@usp.br)

## QUANTITATIVE ASSESSMENT PROPOSAL OF FOOT ARCH DEVELOPMENT FOR EARLY CHILDHOOD

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**Introduction** During the early childhood, child foot has covered by fixed fat pad which protected their foot from overloading until the skeletal system has adapted to the vertical load during stance and gait. The fat pad is absorbed and the longitudinal arch of the foot is said to continue to develop until the age of 6 years. The purpose of this study is to present a new quantitative assessment of foot arch development from the review of "child's foot arch assessment" articles. **Methods** A literature search of ScienceDirect and CiNii used the following keywords alone and in combination: "footprint" AND "child": "plantar" AND "evaluation". The term "foot development" was also used in combination with the above terms. The reference lists of relevant publications derived from the above electronic search were scanned. It was searched by one investigator for all years available up to February 2015, without language restriction. **Results and discussion** Main results that have been described in the collected literature were, as follows: the literatures of footprint assessment were 1,516 (English literatures were 1,450, Japanese literatures were 66). The visual assessment literatures(60) and the ratio of area assessment literatures(70) were target to review. In accordance with ligaments and skeletal is formed, the child's foot arch is formed from the middle. Instead of a medial gap caused by the longitudinal arch a characteristic fat pad can be found on the medial margin of the midfoot. However, it is not clear how evaluate such kind of the child's foot arch development even a large number of researches have been carried out research into the evaluation of footprint. It was seemed that the length and width information have some advantage because the area was able to calculate from length and width and visual assessment would be extend to distance. Therefore, proposal of a new quantitative assessment of child's foot arch development is as follows. **【1st stage】** Descriptive (D): medial longitudinal arch (MLA) is comes enter in from the inner tangent (IT). Quantitative (Q): Maximum width of IT-MLA **【2nd stage】** D: Medial gap (MG) caused by the development of MLA can be found on the center of the midfoot. Q: MG's width and length **【3rd stage】** D: MG expand to near MLA. Q: MG's width and length and Maximum width of IT-MLA **【4th stage】** D: MG reaches to MLA. Q: MLA-MG's width and length. **【5th stage】** D: outer longitudinal arch (OLA) comes enter in from outer tangent (OT) . Q: Maximum width of OT-OLA. Vertical distance from MG's width and length. **Conclusion** Child's foot arch is considered to be an important component of musculoskeletal assessment in clinical practice and research. However, many measurement approaches were not clear how evaluate the child's foot arch development process. Quantitative assessment of foot arch development for early childhood was developed in this study. This information should be helpful to evaluate the child's foot arch development forming process with regard to foot shape and function. Contact [allurekeiko@gmail.com](mailto:allurekeiko@gmail.com)

## Sport Technology

### RUNNING SPEED ESTIMATED FROM FOOT CONTACT TIME AND STRIDE FREQUENCY

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**Introduction** The global positioning system (GPS) is often used to monitor running speed. However, it cannot be used indoors and GPS functions less well when the signals are poorly received. Moreover, its accuracy declines when sharp turns or bends are made or rapid changes in speed occur. As an alternative, small inertial sensors are used to provide runners with estimates of their running speed. A few of these commercial devices have been validated, but only under laboratory conditions and the protocols and algorithms used to derive running speed from these sensors are proprietary and consequently unknown. However, it seems likely that either foot contact time (CT) and/or stride frequency (SF) are used to estimate running speed. Therefore, we investigated the validity and reliability of speed estimates from foot contact time (CT) and stride frequency (SF) during outdoor running on tarmac, thus under ecological conditions. **Methods** Participants signed written consent forms and the study was approved by the local ethics committee. CT and SF were measured with tri axial inertial sensors attached to the feet of 14 runners who varied in training background. They wore a Garmin Forerunner 620 sports watch with GPS function. First, the relationships between running speed with CT and with SF were established with participants running six 125m intervals at different speeds. These relationships were subsequently used to estimate speed during a 4km run. Stopwatch derived speed during the 4 km runs, measured for each of the 32 consecutive 125m intervals, was used as reference. The measurements were repeated on another day. **Results** Individual speed-CT relations, but not speed-SF relations, were strong ( $r^2 > 0.96$  for all trials) and consistent between days. During the 4km runs, errors (%) for SF, CT and GPS derived speed respectively were  $7.6 \pm 5.5$ ,  $2.7 \pm 1.3$  and  $1.6 \pm 0.2$  ( $P < 0.05$  between methods) while the correlation with stopwatch-speed, indicating how well small speed fluctuations were monitored during the 4 km runs, respectively were  $0.59 \pm 0.27$ ,  $0.89 \pm 0.08$  and  $0.82 \pm 0.11$  ( $P < 0.05$  between methods). **Discussion** Participants ran a straight course in an open area, which probably minimized the errors in the speed estimates for GPS. We noted that GPS became less ( $P < 0.05$ ) accurate around the turning point at 2 km. The present study was limited to running on flat terrain, but included various weather conditions. We noted that the speed-SF relation was affected by head or tailwinds, while the speed-CT was unaffected by wind. **Conclusion** Running speed estimates based on individual speed-CT relations, but not speed-SF relations, have acceptable accuracy during natural outdoor over ground running on flat terrain. Contact: [c.j.de.ruiter@vu.nl](mailto:c.j.de.ruiter@vu.nl)

## Sports Medicine and Orthopedics

### THE TNF-ALPHA SYSTEM IS SUBSTANTIALLY INVOLVED IN MARKED MUSCLE OVERUSE

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**Introduction** Muscle inflammation (myositis) and damage can occur in response to heavy exercise. The cytokine TNF $\alpha$  has marked effects in situations with inflammation, damage and tissue reorganization. However, there has been a lack of information concerning the TNF $\alpha$  system for muscle tissue when a muscle is subjected to marked overuse. We use an experimental rabbit model for which the triceps surae muscle is subjected to marked overuse and for which we have noted that TNF $\alpha$  is existing in the infiltrating white blood cells and in muscle fibers, both necrotic or regenerative muscle fibers (1,2). The expression pattern of TNF $\alpha$  receptors in overused muscle is unknown why this was examined in the present study. **Methods** An animal (rabbit) model leading to marked muscle overuse for the triceps surae muscle was used. This model has been used in previous studies evaluating the processes that occur in overused muscle (1,2). The soleus part of the triceps surae muscles was analyzed with immunohistochemistry. Antibodies against TNF receptor I and II (TNFRI and II) were utilized. **Results** A muscle inflammation (myositis) occurred within parts of the muscle specimens. That included presence of muscle fiber necrosis. TNFRI and TNFRII immunoreactions occurred for the infiltrating white blood cells, small vessels and in muscle fibers in myositis areas, some of which were necrotic fibers. Interestingly, immunoreactions for both types of receptors were also seen in nerve fascicles in the myositis areas. **Discussion** The present study, coupled with our previous studies (1,2), shows that the TNF $\alpha$  system to a large extent is involved in overexerting muscle. The two TNF receptors TNFRI and II were thus extensively expressed. That included expressions within the inflammatory cells, muscle fibers as well as nerve structures. The TNF $\alpha$  system therefore seems to be an important system in myositis processes that occur in response to marked muscle overuse. This is likely to be related to both regenerative and degenerative/necrotic processes. This is of relevance when considering the fact that muscle inflammation and damage are features that frequently are associated with heavy sport activities. **References** 1. Forsgren S et al. TNF-Alpha in the Locomotor System beyond Joints: High Degree of Involvement in Myositis in a Rabbit Model. *Int J Rheumatol.* 2012;2012:637452. 2. Renström L et al. TNF-alpha in an Overuse Muscle Model - Relationship to Muscle Fiber Necrosis/Regeneration, the NK-1 Receptor and an Occurrence of Bilateral Involvement. *J Clin Cell Immunol;* 2013.4:2 ISSN 2155-9899

### RELATIONSHIP BETWEEN LOWER EXTREMITY ALIGNMENT DURING SINGLE-LEG SQUAT TEST AND THE HIP MUSCLE STRENGTH

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Dynamic alignment is an important role to evaluate dynamic movements in sports. Single-leg squat test (SLS) is considered as an effective evaluation approach of dynamic alignment in lower extremity. Poor functions of hip muscles cause a mal-alignment such as valgus knee posture during SLS. Then strengthening the hip muscles is effective to prevent the mal-alignment of lower extremity that may cause injuries. Previous study reported the hip muscle activity showed minimum value at the specific position during the SLS (knee flexion angle at 60deg). The purpose of this study was to investigate the relationship between the hip muscle strength at the position where hip muscle activity is low, and alignment of lower extremity in SLS. Twenty six males participated this study (19.8 $\pm$ 2.2yrs, 173.7 $\pm$ 16.3cm, 64.3 $\pm$ 13.3kg). Lower extremity alignment (Q-angle) and trunk motion during SLS were evaluated using 3D motion analysis method (Frame-DIAS). And isometric muscle strength of hip joint was evaluated by handheld dynamometer. In addition, we divided the subjects into two groups rating Q-angle in frontal plane as "decrease" or "increase" when the knee angle changed from 30° to 60° in sagittal plane in performing SLS. Then we compared "decrease" group with "increase" group in hip strength, Q-angle and trunk posture. There was significant correlation between the hip abduction strength and Q-angle ( $r=0.39$ ,  $p<0.05$ ). There was no significant difference between two groups in hip strength. But the "decrease" group tended to show larger lateral bent of the trunk to support side of SLS. In general, hip abduction muscles prevent the increase of Q-angle (knee valgus angle). However, this study showed a contradict result from anatomical principle. "Duchenne's sign" was showed in the "decrease" group as compensate movement of valgus knee posture. The result that was considered compensates movement as an inclination of trunk had an effect on alignment of lower extremity. In a word, to evaluate an alignment of lower extremity by only isometric hip abduction strength may be insufficient in evaluation of alignment. Therefore, when we evaluate alignments, we should consider factors such as inclination of trunk and sole of foot pressure.

### PREVALENCE AND CHARACTERISTICS OF OSTEOCHONDRITIS DISSECANS OF THE ELBOW AMONG ADOLESCENT BASEBALL PLAYERS

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**Introduction:** Osteochondritis dissecans of the elbow (OCD) is a condition that occurs in children and adolescents who participate in sports that place a large amount of stress on the humeral capitellum. Baseball, a popular sport in Japan, is one of the high risk sports which induces OCD. Many children start playing baseball during elementary school. Recently, medical check-ups for OCD in adolescent baseball players utilizing ultrasonography is becoming more popular. The prevalence and clinical characteristics of OCD among adolescent baseball players are unknown. The aim of this study was to investigate the frequency and clinical characteristics of OCD among adolescent baseball players. **Methods:** The subjects were 3310 young baseball players from 12 to 17 years (mean, 13.6 years) who participated in medical check-ups for OCD. The elbow of each subject's throwing arm was assessed using a questionnaire and ultrasonography. Subjects with abnormal results on ultrasonography were further examined through radiographic study. OCD lesions were classified into stages based on radiographic results. We compare the differences of demographic data between OCD players and non-OCD players. **Results:** OCD was detected in 101 (3.1%) of 3310 elbows by ultrasonogram. Eighty-seven of the 101 OCD players underwent further radiographic examination. Six of them (6.9%) were stage S (superficial stage), 17 (19.5%) were stage I (radiolucent stage), 32 (36.8%) were stage II (fragmentation stage), and 9 (10.3%) were stage III (loose body stage). An additional 9 (10.3%) players were stage IV (residual stage), and 14 (16.1%) were stage V (postoperative stage). There was no significant difference on the starting age of playing baseball ( $p = 0.094$ ).

Players with OCD had longer duration of competitive play ( $p < 0.001$ ). They also had present ( $p = 0.003$ ) and past elbow pain ( $p < 0.001$ ) compared to non-OCD players, however fifty five OCD players in stage S, I and II (before loose body stage) had no significant differences. Discussion: Players with OCD had longer baseball career but players in stage S, I and II do not have significant present elbow pain compared to non-OCD players. Medical check-ups of adolescent baseball players utilizing ultrasonography is useful for detecting OCD with no associated elbow pain. Contact: thoj@mail.doshisha.ac.jp

### **AGE DIFFERENCES IN DYNAMIC ALIGNMENT DURING SINGLE-LEGGED SQUATTING AND DROP LANDING IN FEMALE BASKETBALL PLAYERS**

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**Introduction** Anterior cruciate ligament (ACL) injury occur by dynamic knee valgus during landing tasks. To identify athletes at a higher risk, we developed a two-dimensional (2D) screening test focused on hip abductor and rearfoot function (Kagaya et al., 2013). However, age differences in hip or rearfoot motion as a contributor to dynamic knee valgus remains unclear. This study aimed to determine how age differences contribute to hip or rearfoot motions. **Methods** One hundred-four female basketball players (31 junior high-school, 42 high-school and 31 college students) agreed to participate in this study. Participants were required to perform single-legged squatting and drop landing from a 30 cm box. This procedure was recorded using a 2D video camera in the front and the back. Knee-in distance (KID) was measured as the distance from hallux to the point where the line connecting the center of the patella and the anterior superior iliac spine (ASIS) intersects the floor. Hip-out distance (HOD) was measured as the distance from hallux to the projection of ASIS on the floor. Hip abductor function and rearfoot dynamic alignment was evaluated by a dynamic Trendelenburg test (DTT) and a dynamic heel-floor test (HFT), respectively. Additionally, we measured navicular height on sitting position and navicular drop. Results There was effect of age on DTT-positive during single-legged drop landing ( $p < 0.05$ ). Junior high school athletes were greater prevalence of DTT-positive than high school and college athletes. Additionally, they demonstrated smaller HOD values in single-legged squatting than older athletes ( $P < 0.01$ ). The navicular drop in high-school athletes was significantly smaller than in junior high-school and college athletes ( $p < 0.001$ ), however the navicular height was smaller in junior high-school athletes ( $p < 0.01$ ). **Discussion** Some researchers reported that the females in the late or post pubertal stage were greater dynamic knee valgus than in the early pubertal stage (Hewett et al., 2004, Yu et al., 2005). In our study, junior high-school athletes demonstrated smaller HOD values than older athletes, although KID values were not significant. Higher prevalence of DTT-positive in junior high-school athletes was suggested that the female athletes in early pubertal had not developed the hip abductor function. Player's age is an important consideration in ACL injury preventative conditioning. **References** Kagaya Y, et al. (2013). *J Sport Health Sci*, <http://dx.doi.org/10.1016/j.jshs.2013.08.002>, 1-6. Hewett TE, et al. (2004). *J Bone Joint Surg*, 86-A, 1601-1608. Yu B, et al. (2005). *Am J Sports Med*, 33, 1356-1364. Contact kagaya@nr.showa-u.ac.jp

### **THE RELATIONSHIP BETWEEN MUSCLE LENGTH CHANGE AND MUSCLE ACTIVATION OF BACK MUSCLE DURING APPLIED ROMAN CHAIR STRENGTHENING**

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**Introduction** The Roman chair has been applied to train spinal muscle, however; there were very limited discussions on which postures is more efficient when doing back muscles strengthening (Dolan and Adams, 1993). The purpose of this study is to investigate the relationship between the muscle length change and its corresponding activation of back muscles when applied the Roman chair for muscle strengthening through ultrasound image and surface electromyography (EMG). Understanding the correlations of the contraction of back muscles and muscle length change during training is helpful to design a more efficiency training program. **Method** The "stiff-legged deadlifts" in Roman chair when doing back muscle strengthening was tested in this study. Three back muscles including upper back muscle (lower trapezius), lower back muscle (Erector Spinae) and lower trapezius were studied in this study. The results presentation was from one of the subject who is a graduate student without back muscles injury. The starting position of training was to keep back straight and bent the trunk slowly for 60 degrees. Using the ultrasound images, the length of three muscles could be identified, and surface EMG system (TrignoTM, USA) was used to detect the muscle activation from starting position to bent 60 degrees. The relationship between muscle length change and muscles activation of three testing back muscles were quantified. **Result** During "stiff-legged deadlifts" in Roman chair, the initial muscles length at starting position of the lower trapezius, middle erector spinae and lower erector spine were 2.47cm, 2.94cm and 2.94cm respectively, while at the bent forward 60 degrees, muscles length changed to 2.61cm, 3.17cm, 2.41cm. During bending, the largest muscle activation was lower erector spinae (average was 35 mV), following by the erector spinae (average was 23 mV), and the least was lower trapezius (average was 8mV). **Discussion** This research had found that the muscle length change and muscle activation of the trapezius and middle erector spinae during training had positive correlation. On the contrary, the muscle length change and muscle activation of lower erector spinae had negative correlation. Since the muscle length change represents its contraction type (concentric/eccentric), it is interpretable that all the muscle length change and muscle activation of back muscles have highly correlation. That is, all of three testing back muscles had contraction when applied this kind of training and reached its purpose. This study especially indicated that the lower erector spinae had the best training effect because it was eccentric contraction and had largest muscle activation. Through this kind of study, an efficient muscle strengthening training system could be established for back muscles training.

### **SLEEPING IN MODERATE HYPOXIA AT HOME FOR PREVENTION OF ACUTE MOUNTAIN SICKNESS : A PLACEBO-CONTROLLED, RANDOMIZED DOUBLE BLIND STUDY**

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**Objective:** Acclimatization at natural altitude effectively prevents acute mountain sickness (AMS). It is, however, unknown whether prevention of AMS is also possible by only sleeping in normobaric hypoxia. **Methods:** In a placebo-controlled double-blind study 76 healthy unacclimatized male subjects, 18-50 years, slept for 14 consecutive nights at either FIO<sub>2</sub> of 14-15 % (average target altitude 3043 m; treatment group) or 20.9 % (control group). 5 days later AMS scores and incidence of AMS were assessed during a 20-hour exposure in normobaric hypoxia at FIO<sub>2</sub>=12 % (equivalent 4500 m). **Results:** Due to technical problems with the nitrogen generators target altitude

was not achieved in the tents and only 21 of 37 subjects slept at an average altitude considered sufficient for acclimatization (above 2200 m; average 2600 m). Therefore, in a subgroup-analysis these subjects were compared to the 21 subjects of the control group with the lowest sleeping altitude. This analysis showed a significantly lower AMS-C score (0.38 (95%-confidence-interval 0.21-0.54) vs. 1.10 (0.57-1.62),  $p=0.04$ ) and lower Lake Louise Score (3.1 (2.2-4.1) vs. 5.1 (3.6-6.6),  $p=0.07$ ) for the treatment-subgroup. The incidence of AMS defined as an AMS-C score  $>0.70$  was also significantly lower (14 vs. 52 %;  $p < 0.01$ ). Conclusion: Sleeping 14 consecutive nights in normobaric hypoxia (equivalent to 2600m) reduced symptoms and incidence of AMS 5 days later on exposure to 4500 m.

### MEDICAL EVALUATION OF MUSCULOSKELETAL DISORDERS IN STUDENTS USING THE "HEALTH NOTEBOOK"

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Introduction In Japan, each school is required to conduct physician-performed medical examinations of all elementary and junior high school students. In addition, Japan's Ministry of Education, Culture, Sports, Science and Technology has decided to include a 'medical evaluation of the extremities' in these examinations, beginning in April 2016. Previous studies have estimated that the prevalence of musculoskeletal disorders is approximately 7%, and that the approach to musculoskeletal disorders are finally close-up. Since 2008, we have used the 'Health notebook' to screen for musculoskeletal disorders among elementary and junior high school students; we describe the findings below. Material and Methods We developed the 'Health notebook', which includes a musculoskeletal disorders check list, and began musculoskeletal screening in the elementary and junior high schools of Tsukuba city, Ibaraki Prefecture, during 2008. Orthopedic surgeons performed the screenings, and recorded their findings in this notebook, which the record can be stacked every year. We summarized the results from 1 school with 7 years of continuous medical screening data that was recording using the notebook. Results In 2014, musculoskeletal disorders were observed in 41.7% of the students, including symptoms of tightness in 35.0% of the students. We found that 3.1% of the students had severe symptoms that required secondary screening; these findings were consistent over the 7-year period. Discussion It is possible to perform examinations while comparing the findings to those in the previous year, which can help identify changes in students' musculoskeletal status over time. These records are likely a useful communication tool that can help the students, parents, teachers, and doctors better understand the student's health. Conclusion In sporadic screening, it is difficult to track the type and extent of the disorders that are associated with growth. If the 'Health notebook' is used effectively as a continuous evaluation tool, musculoskeletal disorders can be confirmed at an early stage during the students' growth period, thereby facilitating early and more effective treatment.

### FINGER PULLEY INJURIES. DIAGNOSIS AND CHARACTERIZATION WITH MR IMAGING AT 0,5T

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INTRODUCTION: Pulley ruptures are an injury mainly in rock climbers(1), with report a 19% to 26% incidence in population surveys(2). Ruptures most commonly affect the A2 and A4 pulley(3). Pulley ruptures were rare among the general population but now is seen much more commonly in no specialized participants, and information regarding diagnosis and treatment can be limited(1). To determine the ability of MRI to depict finger pulley injuries in rock climbers and others sports and activities. To evaluate MRI in the diagnosis and characterization of lesions of the finger flexor A2 pulley and A4 pulley(4) in patients with clinically suspected pulley lesions. MATERIALS AND METHODS: Fourteen consecutive patients with clinically suspected lesions of the annular pulley system were included in this retrospective study. Ten rock climbers, two judokas, one metal worker and one hotel attendant were examined by using 0.5T MRI with T1-weighted, T2-weighted fat suppressed, and STIR sequences. The distance between the flexor tendon and phalanx was evaluated in forced flexion at the level of the A2 and A4 annular pulleys as an indicator of tendon bowstringing. The images were analyzed and pulley lesions characterized(5). RESULTS: In the 14 symptomatic fingers 14 pulleys were abnormal at MRI. Characterization of the different pulley lesion was possible. MRI depicted 11 complete A2 pulley ruptures(78,57%), 3 complete A4 ruptures(21,42%). Also MRI depicted 10 volar plate rupture(71,42%). Measurement of distance between the flexor tendon and phalanx was significantly different among patient subsets without pulley ruptures and those with complete, or complete combined pulley ruptures(1). A distance between the flexor tendon and phalanx greater than 5.0 mm was interpreted as positive for a complete pulley injury(2). The fourth(n=7) and the third(n=4) fingers are the most frequently injured. Also, fifth(n=2) and second(n=1) fingers were affected. CONCLUSION: MRI at 0.5T allows excellent depiction and direct visualization and characterization of A2 and A4 finger pulley injuries. BIBLIOGRAFÍA 1.Kubiak EN, Klugman JA, Bosco JA. Hand injuries in rock climbers. Bulletin of the NYU hospital for joint diseases. 2006;64(3-4):172-7. 2.Klauser A, Frauscher F, Bodner G, Halpern EJ, Schocke MF, Springer P, et al. Finger pulley injuries in extreme rock climbers: depiction with dynamic US. Radiology. 2002;222(3):755-61. 3.Crowley TP. The flexor tendon pulley system and rock climbing. Journal of hand and microsurgery. 2012;4(1):25-9. 4.Goncalves-Matoso V, Guntern D, Gray A, Schnyder P, Picht C, Theumann N. Optimal 3-T MRI for depiction of the finger A2 pulley: comparison between T1-weighted, fat-saturated T2-weighted and gadolinium-enhanced fat-saturated T1-weighted sequences. Skeletal radiology. 2008;37(4):307-12. 5.Clavero JA, Alomar X, Monill JM, Esplugas M, Golano P, Mendoza M, et al. MR imaging of ligament and tendon injuries of the fingers. Radiographics : a review publication of the Radiological Society of North America, Inc. 2002;22(2):237-56.

### EFFECTS OF EXERCISE MODES ON THE HEMODYNAMIC PARAMETERS DURING GXT

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The aim of this study is to exam the effects of exercise modes on the systolic blood pressure and rate-pressure product during a gradually increasing exercise load from low to high intensity. For the purpose, fifteen apparently healthy adults performed the graded exercise tests on cycle ergometer and treadmill. During the low-to-maximal exercises, hemodynamic parameters including oxygen uptake, heart rate, systolic blood pressure and rate-pressure product were tested. As result, There was a significantly lower maximum VO2 on cycle ergometer than treadmill ( $p<0.01$ ). However, CE showed a higher maximum SBP at the all-out exercise load than TM ( $p<0.001$ ). During the low-to-maximal intensity increment, the slope of the HR with VO2 was the same as VO2 increased in times of the graded exercise test of CE and TM. The slope of increase on SBP accompanied by VO2 increase was significantly higher in CE than in TM ( $p<0.01$ ). In conclusion, the response of systolic pressure in cycle ergometer is stronger than in treadmill during the graded exercise test (GXT). Therefore, it was shown a possibility that exercise by cycle ergometer could induce a greater burden on workloads to cardiovascular system in humans than exercise by treadmill.

**EPIDEMIOLOGY OF INJURIES IN JAPANESE ELITE HANDBALL PLAYERS**

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**Introduction** Handball is a contact sport and hence has a high frequency of injury (Engebretsen et al., 2013). However, injury in Japanese elite handball players has not been well documented. The purpose of this study was to investigate the pattern of injury in Japanese elite handball players using the data from past medical checks. **Methods** We analysed the medical check data of the Japanese national handball team that has performed at the Japan Institute of Sports Sciences since 2002. Medical checks were conducted 6 times for men and 7 times for women from 2002 to 2014. There were 75 male players (144 players in multi-year) and 62 female players (126 players in multi-year), averaging 24 players and 18 players, respectively. We prepared a problem list for each player, which was classified as Active (requiring medical treatment and detailed checking), Follow (requiring follow-up) and Inactive (healed status and closed case). We analysed the injury patterns of Japanese elite handball player from the problem lists. **Results** The number of male and female players with Active cases averaged 3.8 (16%) and 3.7 (19%), respectively, at each medical check. Moreover, there were 4.5 Active male cases and 4.6 Active female cases; some players had multiple Active cases. The sum of players having Active and Follow cases was 18.7 (78%) in males and 14.3 (79%) in females. The knee (24% and 34%, respectively) in males and females was the most commonly injured anatomical location, followed by the ankle (20% and 23%, respectively), shoulder (16% and 13%, respectively) and lumbar region (16% and 12%, respectively). The most common injury in each anatomical location in males and females was to the anterior cruciate ligament in the knee, sprain/instability in the ankle and rotator cuff injury in the shoulder, at each medical check. **Discussion** We researched the injury pattern of Japanese elite handball players from past medical checks. Injury to the knees, ankles and shoulders were common in both sexes. Injuries in these locations greatly influenced handball players' performance; hence, preventive measures to prevent potential injuries in these locations are needed. Moreover, to link the injury data with the development of preventive methods, it is necessary to implement regular surveys and for systematic surveillance studies, including items such as recording absence from sport and standardizing the criteria for problem determination. **References** Engebretsen, L., Soligard, T., Steffen, K., Alonso, J. M., Aubry, M., Budgett, R., ... Renström, P. A. (2013). *British Journal of Sports Medicine*, 47(7), 407–14. Contact patagonia.imoto@gmail.com

**PREVALENCE OF RISK FACTORS FOR SHOULDER INJURIES IN COLLEGIATE HANDBALL PLAYERS DURING PRESEASON SCREENING**

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**Introduction** Shoulder injuries are among the frequently encountered injuries in handball (Olsen et al. 2006). The aim of this study was to evaluate the prevalence of intrinsic risk factors for shoulder injury in collegiate handball players during preseason screening. **Methods** 20 collegiate handball players (male, 15; female, 5; age,  $19.2 \pm 0.7$  years; height,  $169.1 \pm 6.6$  cm; body mass,  $65.4 \pm 8.9$  kg; handball experience,  $6.3 \pm 2.0$  years) participated in the study. All players received a preseason screening that included basic demographics, history of injuries, and physical findings in throwing arm. We collected data on history of injury, range of motion [ROM], isometric muscle strength, joint instability, and special tests for the rotator cuff. A goniometer was used to measure shoulder passive ROM of internal rotation [IR], external rotation [ER], horizontal flexion [HF] and horizontal extension [HE]. A handheld dynamometer was used for measurement of isometric muscle strength during shoulder IR and ER. Player with a history of injuries, or those who with an anterior joint instability, or those who result in the positive special tests, were classified as shoulder injury risk [SIR] group. Other players were classified as healthy [H] group. **Results** 9 players (45%) were classified into SIR group as a result of medical screening. The following data shows the number of positive result of each risk factor; history of injury, 6; anterior joint instability, 3; empty can test, 3; full can test, 4; hawkins kennedy test, 6; neer test, 1. ER ROM was significantly lower in SIR group ( $90.6 \pm 9.8$  degrees) compared with H group ( $100.5 \pm 9.2$  degrees) ( $p < 0.05$ ; effect size, 1.05). HE ROM was significantly lower in SIR group ( $23.3 \pm 10.0$  degrees) compared with H group ( $30.9 \pm 5.1$  degrees) ( $p < 0.05$ ; effect size, 0.99). IR muscle strength was significantly lower in SIR group ( $2.27 \pm 0.5$  N/body mass) compared with H group ( $2.80 \pm 0.4$  N/body mass) ( $p < 0.05$ ; effect size, 1.10). ER muscle strength was significantly lower in SIR group ( $2.56 \pm 0.4$  N/body mass) compared with H group ( $3.31 \pm 0.7$  N/body mass) ( $p < 0.05$ ; effect size, 1.29). **Discussion** The intrinsic risk factor of shoulder injuries were found in many collegiate handball players during preseason screening. Players with risk factors had lower ROM and muscle strength in their throwing arm. This is consistent with previous study in other athlete (Ogaki et al. 2014). Decreasing the shoulder ER ROM and muscle strength was reported risk factors for shoulder injuries among elite male handball players (Clarsen et al. 2014). Improvement of the ROM and/or muscle strength in preseason might therefore help to prevent shoulder injuries among handball players. **References** Clarsen B, Bahr R, Andersson SH, Munk R, Myklebust G. (2014). *Br J Sports Med*, 48(17), 1327-1333. Ogaki R, Takemura M, Iwai K, Miyakawa S. (2014). *Int J Sport Health Sci*, 12, 31-37. Olsen OE, Myklebust G, Engebretsen L, Bahr R. (2006). *Scand J Med Sci Sports*, 16(6), 426-432. Contact Ryo Ogaki, r.ogaki731@gmail.com

**INJURIES IN AN ELITE FEMALE SOCCER TEAM FROM THE SPANISH FIRST DIVISION: AN 11-SEASON PROSPECTIVE STUDY**

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**INTRODUCTION:** The first step in soccer injury prevention is to assess injury epidemiology. However, elite female soccer players, particularly those from southern European countries, have been scarcely investigated. Thus, the aim of this study was to describe the occurrence of injuries in an elite female soccer team from the Spanish first division. **METHODS:** Athletic Club Bilbao's elite female team was prospectively followed for 11 seasons from 2003 to 2014 (63 total players, mean $\pm$ SD,  $21.9 \pm 1.6$  players per season,  $24.3 \pm 4.7$  years old). Time-loss injuries were diagnosed and recorded by the team's medical staff. **RESULTS:** A total of 278 injuries were recorded, 52.7% during training and 46.9% during matches. Recurrent injuries accounted for 19.8% of all injuries. 74.8% of injuries occurred in non-contact situations, and there was a similar amount of traumatic (48.4%) and overuse (51.6%) injuries. 89.2% of injuries affected the lower limbs, with the thigh (30.2%), ankle (18.0%) and knee (16.2%) being the most common locations, and muscle (47.1%) and articular (36.7%) injuries being the most common types. Conversely, only 4 cases of pubalgia and no concussions were recorded. On average, there were  $13.7 \pm 3.4$  ( $62.7 \pm 14.9$ ) players injured per season, with each player sustaining  $1.2 \pm 1.3$  injuries and losing 36.4 days (median 7.9). There were  $25.3 \pm 8.4$  injuries per season, specifically,  $4.5 \pm 2.4$  quadriceps strains,  $2.8 \pm 1.8$  ankle lateral ligament sprains,  $2.5 \pm 1.2$  hamstring strains,

2.3±1.3 adductor strains, and 1.0±0.6 anterior cruciate ligament ruptures. Most injuries were of moderate severity (41%, 8-28 days lost). Knee injuries accounted for 52% of total days lost (150.6 days lost per injury, median 33), and were more severe than muscle strains (17.4 days lost, median 12,  $P=0.02$ ) and ankle sprains (18.6 days lost, median 11,  $P=0.03$ ). The number of injuries, especially quadriceps strains, was higher during the pre-season ( $P<0.01$ ). DISCUSSION: Contrary to previous reports in elite female soccer players, where ankle, knee and hamstring injuries were predominant (Hagglund et al 2009), quadriceps strains were the most common injury in this team. The high percentage of overuse injuries and the lack of concussions are also noteworthy. Further research is required to explain these findings. The lack of exposure data is the main limitation. Based on these results, prevention strategies should target thigh muscle strains, ankle sprains, and most important, severe knee injuries. REFERENCES: Hagglund M, Walden M, Ekstrand J (2009). Scand J Med Sci Sports, 19, 819-827. Contact: j.larruskain@hotmail.com

### THE INFLUENCE OF EXERCISE SPEED IN MUSCULAR STRENGTH EXERCISE, ON THE RATING OF PERCEIVED EXERCISE, VITAL SIGN, AND STRESS BIOMARKER RESPONSE

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**Introduction** The low-intensity resistance exercise with slow and tonic movement (LST) is a one of the effective method on the muscular strength exercise. (Tanimoto M. & Ishii N., 2006 ) The salivary amylase has been known as one of the stress biomarker (Yamaguchi, 2007) The purpose of this study was to compare with the RPE, vital signs, and saliva amylase activation between LST and the low loaded resistance exercise with normal speed (LN). **Methods** This study comprised 29 healthy male volunteers (LST:15, LN:14). All volunteers performed knee extension exercise (8times×3sets) with 30%1RM load at each exercise speed (LST : con/ecc = 3sec/3sec, LN : con/ecc = 1sec/1sec). The RPE, blood pressure, and heart rate were measured immediately after each sets of exercise. The salivary amylase activation was measured at time of pre-exercise, immediately after 3rd set, and 30 minutes after exercise. The salivary amylase activation after exercise was quantitated by the amount of change from pre-ex value. **Result** The salivary amylase activation of LST and LN had mean amount of change of 20.9+/-24.2KU/L and 6.5+/-2.5.2KU/L respectively, before exercise. Although there were no statistically significant different between LST and LN, the salivary amylase activation in LST was much increase than LN. The RPE of LST showed a high value from LN significantly. In both groups after each set, the blood pressure and heart rate had not changed remarkably from pre-exercise value. **Discussion** In blood pressure and heart rate, these results suggested the LST could be a promising exercise method in the rehabilitation for circulated disease and elderly. However it was necessary to pay attention to RPE and a stress. **Reference** Tanimoto M, Ishii N: Journal of Applied Physiol 100: 1150-1157, 2006. Yamaguchi M. (2007). Folia Pharmacologica Japonica, 129, 80-84.

### DROPOUT RATE OF ITALIAN RANGER TRAINEES: WHO IS THE ENEMY?

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In the Italian Army, a specific process selects the highest calibre soldiers to be enrolled in the successive highly demanding, 2-years Rangers Training Program. Yet, preliminary statistics indicate a dropout (DO) rate of 50%. The most critical phase is the first 6 months of the program, the so-called OBOS course, when roughly 63% of the total DO occurs. **PURPOSE:** This pilot observational study was aimed at determining the causes of DO during the OBOS and identifying possible predictor characteristics, with the final aim to prevent DO by optimising selection strategies and training practices. **METHODS:** In a total of 103 male recruits (26±2 yrs) we monitored DO date and cause (clustered in Personal P, Technical T, and Medical M) and measured anthropometric (body mass; stature; plicometry) and functional characteristics (pull-ups; dips; push-ups; sit-ups; 2km run). The possible association of specific anthropometric or functional parameters with DO was evaluated by unpaired t-test between the successful vs DO groups. **RESULTS:** The body weight, stature, fat mass and the results of the functional tests are similar to those reported in the literature for special forces trainees in Europe (1, 2). 42 recruits (41% of the total) abandoned the program during the OBOS phase. The main cause of DO was voluntary withdraw for personal reasons (60% of total dropouts); 30% of the recruits were excluded from the program for medical reasons; 10% of the recruits were excluded for technical reasons (e.g. discipline issues, fail of technical exams or physical requirements). Significant differences between successful and DO groups were detected in % body fat (11±3 vs 13±3) and the number of pull-ups (12±3 vs 11±4). **CONCLUSIONS:** Ours are the first available data on Italian Army Ranger trainees. The DO group was characterised by increased body % fat and reduced upper body strength compared to the successful group. Data would suggest targeting individual motivation, self-efficacy and resilience upon admittance to the program as potential factors affecting DO. Furthermore, optimal physical preparation practices (including gradual overload and injury prevention strategies) and optimal medical treatment could potentially reduce DO for medical and technical reasons. **REFERENCES** 1. Davey T, Delves SK, Lanham-New SA, Allsopp AJ, Fallowfield JL. Body composition of Royal Marine recruits during 32 weeks of military training. Proceedings of the Nutrition Society (2011), 70 (OCE4), E150 doi:10.1017/S0029665111002011 2. Sporis G, Harasin D, Bok D, Matika D, Vuleta D. Effects of a training program for special operations battalion on soldiers' fitness characteristic. Journal of Strength and Conditioning Research 2012 National Strength and Conditioning Association 26(10)/2872-2882

### INJURY IN JAPANESE FEMALE UNIVERSITY JUDO ATHLETES

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**Introduction** Judo is a martial art. A lot of injuries occur during Judo not only slight injuries like contusion but also severe injuries like catastrophic head and neck injuries. Epidemiology of judo injury is limited, especially in Japanese judo athletes. To prevent injuries, it is necessary to investigate the epidemiology of Judo injuries. The purpose of this study was to investigate the frequency and characteristic of injuries in Japanese female university Judo athletes. **Methods** Medical records of a Japanese female university Judo club (numbers of athlete: 35, age: 18-22 y) collected by an orthopedic surgeon were analyzed retrospectively in 2013 seasons (from April 2013 to March 2014). **Diagnosis**, injured body part, type of injury and injured body side were extracted. Percentage of injured athlete was calculated. **Results** One-hundred and twenty-seven injuries occurred in 2013 seasons. Thirty-one out of 35 players (89%) sustained an injury. Incidence of injury was 3.61 (injury/player/year). Two injuries required surgery; lateral meniscus injury and cervical disc herniation. The most common injured part was knee joint (20%), followed by neck (11%) and elbow joint (9%). Six head injuries occurred (5%). Almost half of all injuries were to lower extremities (47%) and 28 % to upper extremities. The most common type of injuries was sprain (21%), followed by muscle spasm (15%), ligament injury (13%) and contusion (9%). As a severe head injury, 4 concussions occurred in a year. Eight ligament

injuries occurred in the knee; 5 medial collateral ligament injuries, 2 posterior cruciate ligament injuries and 1 lateral collateral ligament injuries. Discussion Head injuries sometimes link to catastrophic injury. Kamitani et al. reported that 90% of head injuries occurred in athletes younger than 20 years of age. In this study, 5 of 6 head injuries and 3 of 4 concussion occurred in athletes younger than 20 years of age. These results revealed that young athletes may be more vulnerable to severe head injuries. The present study provide a injury frequency in female university judo athletes. These results are helpful for identifying the risk factor and mechanism of judo injury and developing effective Judo-related injury prevention program. References Kamitani T, Nimura Y, Nagahiro S, Miyazaki S, Tomatsu T. (2013). *AJSM*, 41, 1915-1921.

### IMPAIRMENTS OF MOTOR PERFORMANCE AFTER TREATMENT FOR PEDIATRIC BONE TUMORS

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**Introduction** After treatment for pediatric bone tumors patients are at high risk of developing physical limitations due to severe surgical interventions (Abded et al. 2010). These consequences persist lifelong (Hoffman et al. 2013) and may also result in impairments of motor performance. Motor performance has not yet been sufficiently investigated in this patient group although it could negatively affect physical activity and the participation in sports in early aftercare. Therefore this study aimed at assessing motor performance in pediatric bone tumor patients. **Methods** The MOON-test was used to determine motor performance within 24 months post-treatment (Götte/Kesting et al. 2013). This instrument enables quantitative data collection even in patients with severe physical impairments and allows comparison with age- and gender-matched reference values. **Results** Data of 21 patients (m=13) aged 15.2±2.1 years (median: 15 years, range: 10-19 years) were collected 9.4±7.4 months post-treatment (median: 6 months, range: 2-24 months). Severe impairments ( $P<0.001$ ) were identified in reaction (91% scored below reference values), flexibility (81% scored below reference values), eye-hand coordination (62% scored below reference values) and muscular explosive strength (89% scored below reference values). The strength endurance of the legs was reduced in 43% of the patients. However, in hand grip strength >33% and in static balance >52% of the patients showed better results compared to the reference values. **Follow-up duration, body mass index and tumor localization** apparently affected motor performance. **Discussion** These findings provide valuable objective information about impairments of motor performance in a group of pediatric bone tumor patients within 24 months post-treatment and highlight the need for interventions to improve motor performance. Well documented reduced physical activity (Winter et al. 2009) might on the one hand be associated with these results, and on the other hand be negatively influenced by these physical limitations. Therefore, the results should be used to individually advise and support patients to engage in suitable physical and sports activities and improve sports promotion already during acute treatment. **References** Abded R, Grimer R. (2010). *Cancer Treat Rev*, 342-347. Götte M/Kesting S, Albrecht C, Worth A, Bös K, Boos J. (2013). *Klin Pädiatr*, 225, 133-137. Hoffman MC, Mulrooney DA, Steinberger J, Lee J, Baker KS, Ness KK. (2013). *J Clin Oncol*, 3, 2799-2805. Winter C, Müller C, Brandes M, Brinkmann A, Hoffmann C, Harges J, Gosheger G, Boos J, Rosenbaum D. (2009). *Pediatr Blood Cancer*, 53, 438-443.

### CO-PREVALENCE OF CERVICAL INTERVERTEBRAL DISK DEGENERATION AND BURNER SYNDROME IN COLLEGIATE-LEVEL AMERICAN FOOTBALL PLAYERS

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**Introduction** American football is a high-energy collision sport that places players at risk for cervical spine injuries. Notably, burner syndrome is frequently induced in players during practices or games. This syndrome occasionally demonstrates a prolonged recovery period, and may lead to a prolonged loss of practice or game time (Meyer et al 1994). Cervical intervertebral disk degeneration (IDD) is another frequent injury in collision sports. However, IDD has not been clearly demonstrated to occur in American football players with a history of burner syndrome. Therefore, this study investigated the occurrence of IDD in collegiate-level American football players with histories of burner syndrome. **Methods** Forty-nine, male, collegiate-level American football players participated in this study (age, 20.0 ± 1.1 years; athletic experience 3.8 ± 2.3 years; height, 172.3 ± 4.8 cm; weight, 83.1 ± 12.2 kg; means ± SD). Burner syndrome was defined as numbness and burning pain from the neck to the hand. Magnetic resonance imaging (MRI) was used to obtain T2-weighted images of cervical regions. Each MRI was assessed, by orthopedists, according to the Pfirrmann classification. IDD severity classification was based on the Pfirrmann (I–V) classification (Pfirrmann CW et al 2001); grade III or higher classifications were defined as representing IDD. The co-incidence of burner syndrome and IDD was statistically analyzed using the chi-square test ( $p < 0.05$ , IBM SPSS statistics 22.0). **Results** Burner syndrome was diagnosed in 19 athletes (39%), and IDD was observed in 22 athletes (45%). Among those with IDD, 13 athletes (59%) also suffered burner syndrome. In the 27 athletes without IDD, only 9 (41%) suffered from burner syndrome. The incidence of IDD was significantly higher in the burner syndrome group ( $p < 0.01$ ). **Discussion** A higher IDD occurrence was observed in athletes suffering from burner syndrome than in those who did not have burner syndrome. Since IDD is accompanied by intervertebral foramina stenosis (Levitiz et al 1997), we believe that the surrounding tissues, such as the cervical nerve root, were deformed. Also, because burner syndrome is accompanied with nerve symptoms, such as numbness and pain, IDD-deformed nerves might be easily damaged by external stress. Although our study design was cross-sectional, we suppose that the preexistence of IDD might be a risk factor for burner syndrome. **In conclusion**, cervical IDD shows a high prevalence in collegiate-level American football players with burner syndrome. **References** Levitiz CL, Reilly PJ, Torg JS. *Am J Sports Med* 25; 73-76, 1997 Meyer SA, Schulte KR, Callaghan JJ, et al. *Am J Sports Med* 22; 158-166, 1994 Pfirrmann CW, Metzdorf A, Zanetti M, Hodler J, Boss N. *Spine* 2001; 26: 1873-1878 Contact [14m0019@nittai.ac.jp]

### RIGHT VENTRICULAR LONGITUDINAL FUNCTION DETERMINES EXERCISE CAPACITY IN TENNIS PLAYERS

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**Introduction** Exercise training induces the change of left ventricular (LV) functional in athlete. The pump function of right ventricular (RV) ejected same volume as the LV stroke volume (Voelkel et al 2006), so, it is a important to evaluate RV function in athlete. However, to evaluate RV function by 2D echocardiography is difficult due to complicated structures. Previous study reported the relationship between LV function and exercise capacity, it is still unclear whether the change of RV function influence exercise capacity in athlete. Therefore, the purpose of this study was to evaluate whether RV function affected exercise capacity in high intensity endurance trained athletes. **Methods** Eight men well-trained tennis players were enrolled in this study. All subjects underwent a cardiopulmonary exercise testing (CPX) using cycle ergometer. RV and LV function was measured by ultrasound echocardiography at rest. Systolic RV and LV longitudinal func-



tion were assessed by tricuspid and mitral annular velocity in systole (S') with tissue Doppler imaging. Additionally, systolic global longitudinal strain (GLS) was measured with 2D speckle tracking imaging, and peak oxygen uptake (peakVO<sub>2</sub>) was assessed as an index of exercise capacity. Results Mean peakVO<sub>2</sub> was 51.0±2.7 ml/kg/min. Relationship between peakVO<sub>2</sub> and RV GLS was significant ( $r=0.74$ ,  $p=0.03$ ), and S' at tricuspid was significant trend observed ( $r=-0.68$ ,  $p=0.06$ ). In addition, peakVO<sub>2</sub> was slightly correlated to LV indices, LV GLS ( $r=0.69$ ,  $p=0.06$ ) and S' ( $r=-0.67$ ,  $p=0.07$ ). Discussion GLS generally decline with aging. In this study, RV function at rest was smaller particularly in athletes with high exercise capacity. Moreover, in the present study, athletes with high aerobic ability tend to be lower RV longitudinal function at rest. Consequently, RV longitudinal function in systole may be more effective than LV longitudinal function to determine the exercise capacity in athlete. References Norbert F. Voelkel, Robert A. Quaife, Leslie A. Leinwand, Robyn J. Barst, et al. (2006). *Circulation*, 114, 1883-1891.

### PHYSICAL CHARACTERISTICS AND THROWING PERFORMANCE OF YOUTH BASEBALL PITCHERS WITH AND WITHOUT A HISTORY OF MEDIAL ELBOW PAIN

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**Introduction** Medial elbow pain (MEP) is common in youth baseball pitchers. Body height and weight have been reported to be associated with MEP due to players with better body figure get more chances to pitch. However, the relationships between physical characteristics and MEP in this age have not been fully understood. The purpose of the study was to investigate the differences in physical characteristics (body composition and elbow soft tissue structures) and throwing performance between youth baseball pitchers with and without a history of MEP. One year follow up study was also conducted to evaluate the effects of growing up on physical characteristics and their relationships with throwing performance. **Methods** Twenty-eight elementary school pitchers (EP group) (10 injured and 18 non-injured with similar ball speed of 24.5 m/s) and 36 junior high school pitchers (JP group) (21 injured and 15 non-injured with similar ball speed of 30 m/s) participated in this study. Body composition was scanned by a dual-energy X-ray absorptiometry. Tendons and ligaments around the elbow were examined by a musculoskeletal ultrasound. Throwing movement was analyzed using an optical motion analysis system integrated with a telemetry electromyographic system. Ball speed was recorded with a sports radar gun. All tests were conducted again one year after the first test. **Results** In the JP group, the injured pitchers had more body fat than the non-injured pitchers (24.3% vs. 17.6%). In the EP group, the injured pitchers demonstrated less elbow flexion angle (91.4° vs. 104.4°) when the shoulder reached its maximal external rotation angle; the injured pitchers also demonstrated less peak muscle activities of pronator teres during cocking phase (131.8% vs. 224.0% MVC) and acceleration phase (181.8% vs. 278.0% MVC). Follow up study showed that the major changes in body composition for all pitchers were increments of bone mineral content (BMC) (2.2 vs. 2.5 kg) and lean muscle mass (LMM) (43.2 vs. 48.7 kg). The amount of BMC ( $r=0.75$ ) and LMM ( $r=0.73$ ) had positive relationships with ball speed. The size of elbow soft tissues were increased. The injured soft tissues around the elbow recovered well without irregular alignment in the injured players. **Discussion** Growing up may increase BMC and LMM in youth baseball pitchers. These changes may contribute to their ball speed. However, greater amount of body fat may be associated with MEP that need to be careful. Less elbow flexion angle during the cocking phase with less peak muscle activities of pronator teres may also be associated with MEP. Strengthening of elbow muscles should be emphasized for injury prevention. Soft tissue injuries can be well recovered during this age that need to be taking good care of. Contact yungshentsai@gmail.com

### THE ASSOCIATION BETWEEN GENERALIZED JOINT HYPERMOBILITY AND SHOULDER MOBILITY IN YOUNG, COMPETITIVE SWIMMERS

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**Introduction** Shoulder overuse injuries frequently occur among competitive swimmers (Wanivenhaus et al, 2012), however, the aetiology of shoulder dysfunction remains unclear (Zemek et al., 1995). Increased shoulder mobility as well as Generalised Joint Hypermobility (GJH), are both suggested being predisposing risk factors for shoulder injuries (Pink et al., 2000, Zemek et al., 1995). An association between GJH and shoulder mobility among young, competitive swimmers has not been studied. The aim of this study was firstly to evaluate the association between GJH and horizontal shoulder abduction (HSA) in young, competitive swimmers, and secondly to describe reference values for HSA among this group. **Methods** In total, 92 pain-free competitive swimmers (age 10-15 years) participated. GJH was evaluated by the Beighton test (BT) a 0-9 scoring system. GJH was classified at cut points  $\geq 5/9$ ,  $\geq 6/9$  and  $\geq 7/9$ . Shoulder mobility was measured as HSA using an inclinometer in a standardized protocol format. A multiple regression analysis was used to reveal associations between GJH and horizontal shoulder abduction, adjusted for sex and age. **Results** Overall, significant associations between GJH and HSA were found. An increase in the BT score was positively associated with an increase of HSA, seen as an increased HSA of 3.9 degrees at BT cut point  $\geq 5/9$ , 5.7 degrees at BT cut point  $\geq 6/7$  and 7.9 degrees at BT cut point  $\geq 7/9$ . Normative values for HSA ranged from 40 to 52 degrees, with a trend towards decreasing HSA by increasing age. **Conclusion** In this study, a significant association was observed between GJH and HSA, as the horizontal shoulder abduction increased with increasing BT scores. The predictive validity of GJH and HSA with respect to shoulder injuries must be assessed in future studies. **References** Pink, M.M., Tibone, J.E. The painful shoulder in the swimming athlete. *Orthop Clin North Am.* 2000 Apr;31(2):247-61. Wanivenhaus, F., Fox, A.J., Chaudhury, S., Rodeo, S.A. Epidemiology of injuries and prevention strategies in competitive swimmers. *Sports Health.* 2012 May;4(3):246-51. Zemek, M.J., Magee, D.J. Comparison of glenohumeral joint laxity in elite and recreational swimmers. *Clin J Sport Med.* 1996 Jan;6(1):40-7. Contact tjunge@health.sdu.dk

### THE EFFECT OF ACUTE MODERATE INTENSITY EXERCISE ON LAND AND THAT IN WARM WATER ON ARTERIAL STIFFNESS IN ELDERLY SUBJECTS

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**Introduction** Age-associated change in the structure and function of arteries might increase the risk of cardiovascular disease. It has been reported that aerobic exercise decreased arterial stiffness in young humans (Kingwell, et al., 1997, Naka et al., 2003, Heffernan et al., 2007). However, it is still unclear the effect of moderate intensity exercise in warm water on arterial stiffness in elderly compared to the moderate intensity exercise on land. Therefore, the purpose of this study was to investigate the effect of 38°C water exercise on arterial stiffness in elderly subjects. **Method** Six healthy elderly subjects performed a 15min of cycling exercise with 50% peak VO<sub>2</sub> on land and

that in 38°C water. Arterial Compliance,  $\beta$  stiffness index, Brachial and Carotid blood pressure, heart rate (HR), and rectal temperature (T<sub>rec</sub>) were measured at baseline, 30min, and 60min after the exercise. T<sub>rec</sub> were continuously measured from baseline to 60min after exercise. All measurements were performed in a quiet and air conditioned room at the same time of the day in the morning. Results T<sub>rec</sub> significantly maintain the elevation after the warm water exercise ( $P < 0.0167$ ). HR slightly increased, and significantly increased at 30min after the warm water exercise ( $P < 0.0167$ ). The arterial compliance was significantly increased, and  $\beta$  stiffness index was significantly decreased at 30min after the warm water exercise. Brachial and Carotid arterial blood pressure also significantly decreased at 30min and 60min after the exercise ( $P < 0.0167$ ), whereas there were no significant changes in the exercise on land. Conclusion The present study showed that arterial stiffness significantly decreased after acute 38°C water exercise. On the contrary, there were no changes after exercise on land in elderly subjects. Although the underlying mechanism is unknown, the results in the present study may suggest that 38°C water moderate intensity exercise may induce decrease in arterial stiffness in elderly.

## RELATIONSHIP BETWEEN SPRINT PERFORMANCE AND MORPHOLOGY OF HIP EXTENSORS

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Running is the essential element of sports performance. Especially, the running ability affects directly to sprint race of track and field. Gluteus maxims muscle (GM) and hamstring muscles have been regarded as an important role on hip extension and sprint performance. Morphology of hamstrings has been measured by a lot of studies, although morphology of GM has been measured rarely because of the difficulty and uncertainty of measuring methods. In addition, researches are limited that examined relationships between morphology of hip extensors and sprint performance. The aim of this research is to examine relationships between function and morphology of hip extensors and sprint performance. Seventeen Japanese male subjects (height 174.7±9.3cm, weight 66.1±13.1kg, age 20.1±2.1yrs) participated in this study. They were sprint athletes in track and field team at university. Muscle thickness was measured by ultrasonic diagnostic equipment on GM and biceps femoris long head (BF). We examined muscle thickness, ratio of muscle thickness BF/GM (ratio BF/GM), and right and left differences of each ratio BF/GM. We measured the single leg triple hop test (SLTH-test) for an index of hip extension power. Three subjects were excluded because of lower extremity injury. Official record of 100m sprint was used for evaluating sprint performance. Right and left differences of ratio GM/BF was significantly relevant to sprint performance ( $r = **$ ,  $p < 0.05$ ). However, muscle thickness and ratio BF/GM were irrelevant to sprint performance. Record of SLTH-test was irrelevant to sprint performance. But right and left differences of SLTH-test showed a tendency to relevant to sprint performance. In this study, we examined the morphology of GM. GM had been regarded as an important role in sprint performance. But GM morphology had no relevance to sprint performance in this study. Higher performance athletes showed larger differences between right ratio BF/GM and left ratio BF/GM. This indicated that hip extensors of higher performance athletes were forced asymmetry load. On the other hand, though it had no significant differences, right and left differences of SLTH-test had a tendency to relevant to sprint performance. These results show that muscle imbalance does not always lead muscle dysfunction.

## EFFECT OF SLEEP QUALITY ON COGNITIVE FUNCTIONS DURING EXERCISE IN HEALTHY YOUNG MEN

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Introduction Sleep plays an important role in recovery from fatigue, memory, skill acquirement and so on. Total or partial sleep deprivation induces reduction in many performances, such as physical or psychological performance. The sleep deprivation has also been associated with cognitive function. Thus, quantity of sleep is needed for keeping these performances and/or functions. On the other hand, quality of sleep also may affect in physical or psychological performance and cognitive function. However, it is not unclear the effect of sleep quality on cognitive function. This study examined the effect of acute reduction of sleep quality on cognitive function during exercise. Methods Eight healthy young men performed cognitive tasks by use of the reaction time and the interference in stroop task during exercise on a cycle ergometer at 30%HRreserve for 8 min following 2 sleep conditions (exposure of bright light for 3h and control). Results and Discussion In Polysomnography (PSG) analysis, sleep latency was significantly increased in bright light condition. In Oguri-Shirakawa-Azumi sleep inventory MA version (OSA-MA) test, the score for refreshing was significantly lower in bright light condition than control condition. These results suggest that the quality of sleep may be decreased by exposure of bright light before sleep. There was no significant difference in reaction time in stroop task during exercise between control condition and bright light condition. Latter part of interference in stroop task during exercise significantly increased in bright light condition. These results suggest that cognitive function, such as sustenance of attention, during exercise was decreased by exposure of bright light before sleep. Conclusion In conclusion, cognitive functions during exercise were decreased by reduction of sleep quality in healthy young men.

## THE EFFECT OF DEHYDRATION ON AIRWAY INFLAMMATION IN JUDOISTS

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Introduction Athletes, who are endurance training in outdoor area sports such as marathon and cross country skiers, is known that they have a high incidence of exercise induced asthma (EIA) and exercise-induced bronchospasm (EIB). However it is not completely clear that what conditions induce EIA and EIB. Judo competitions are organized according to weight class, so some judoists rapidly reduce body weight (RWL) before competition. Athletes use a variety of methods to achieve RWL under limitation of liquid ingestion and energy intake; those limitations may occur to dehydration and may affect airway inflammation, because dehydration may cause reduction of the mucus secretion in upper respiratory mucous membrane. We tested the hypothesis that serum blood osmotic pressure, which show dehydration biomarker, affects airway inflammation in judoists that reduce their body weight. Purpose The purpose of this study is to examine that dehydration affect airway inflammation in judoists. Methods Total number of 24 men college judoists took part in this study. The subjects were investigated twice: before 2weeks (baseline) and the day before game day (post). Judoists were measured their body weight, and collected serum blood to evaluate osmotic pressure that is index of dehydration. Fraction of exhaled nitric oxide (FeNO), which is index of airway inflammations, was measured by a portable NIOX MINO. Results Serum osmotic pressure was significantly increased [baseline 290.7±3.3, post 294±3.8mOsm/L]. FeNO was higher than normal level (53.2±24.3ppb) in 11 judoists. The others judoists had not airway inflammation at baseline (13.0±5.3 ppb). FeNO didn't significantly change in judoists with or without airway inflammation (Pre 31.4±26.2, Post 33.0±25.5ppb). Rate of osmotic pressure change didn't significantly associate with rate of FeNO change.

On the other hand, FeNO increased with change of more than 1.7% osmotic pressure. Discussion There was not correction between change of serum osmotic pressure and FeNO. Many risk factors, that are allergen and air pollution, may affect FeNO in addition to dehydration. However, increase of more than 1.7% osmotic pressure induced airway inflammation. Large dehydration may induce higher airway inflammation in judoists. Conclusion Dehydration with increase of osmotic pressure might induce airway inflammation in judo athletes. References Anderson, S. D., & Daviskas, E. (2000). The mechanism of exercise-induced asthma is ... The Journal of Allergy and Clinical Immunology, 106(3), 453-9.

### WHAT IS THE BEST SQUAT AND DEADLIFT TECHNIQUE?

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**Introduction** Resistance training is becoming increasingly popular for use in both sports as well as rehabilitation. The barbell back squat and deadlift are two fundamental exercises in most strength and conditioning programs. There are, however, no evidence based guidelines regarding the optimal technical performance of these exercises. Therefore, the aim of this pilot study was to investigate if there exist a preferred technical execution of the squat and deadlift exercises among health care professionals and resistance training practitioners. **Methods** An online questionnaire was created where participants were prompted to arrange eight pictures depicting variations of technical executions of the barbell back squat and deadlift exercises in order of preference in respect to both injury prevention as well as performance. To determine the most preferred execution median, mode and proportions were analysed. Qualitative comments justifying the preference of execution was also collected. Results In total, 19 participants answered the questionnaire; 3 physical therapists, 1 physician, 5 personal trainers and 10 weightlifters/powerlifters/crossfit lifters. The analysis showed that the most preferred back squat and deadlift techniques were shown in the respective pictures representing a traditional powerlifting technique. For the back squat 44 % of the participants chose the powerlifting squat as the best technique and for the deadlift, 56 % chose the conventional powerlifting deadlift technique. The qualitative comments as well as the descriptive analysis showed that the least preferred execution of both the back squat and the deadlift was a technical execution with a flexed or hyperextended lumbar spine and/or valgus position of the knees. **Discussion** The results of this study provides preliminary data of a technical execution of the back squat and deadlift exercises that health care professionals and resistance training practitioners in Sweden prefer. For the back squat, a neutral spinal position and a neutral hip, knee and foot alignment was preferred. The most preferred squat technique was the powerlifting style squat which incorporates a low bar placement on the shoulders and a hip-dominant movement which puts the torso at an angle between vertical and horizontal. As for the deadlift exercise, an execution promoting a neutral spinal position was preferred. The most preferred deadlift technique was the powerlifting style deadlift, depicted with a stance of about shoulder width and hips higher than the knees in the starting position. The most concerning methodological limitation in this study is the limited sample included in the study. This is however expected for a pilot study. Moreover, the participants also reported that the online questionnaire with pictures was demanding and would have benefitted by including short films instead of pictures. Further studies of optimal technique in the barbell back squat and deadlift exercises are warranted. Contact Lars.berglund@umu.se

### EFFECTS OF FUNCTIONAL ANKLE INSTABILITY ON COLLEGIATE FEMALE FOOTBALL PLAYERS' PERFORMANCES

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**Introduction** Football is played worldwide by more than 265 million players, of whom 26 million are female players.(Astrid et al., 2007). 17-20% of all injuries are sprains in soccer players (Ekstrand et al., 1990). Ankle sprains cause functional instability in a large proportion of cases. However, no studies have examined a link between functional ankle instability and physical performances. The purpose of this study was to investigate the relationship between functional ankle instability and collegiate female football players' performance. **Methods** 16 collegiate female football players (mean age= 19.7±1.4 years, mean height=159.8±7.6cm, mean weight=56.7±6.1kg) participated in this study. Ankle instability was defined as functional instability based on the Karlsson score. The players were categorized as either having ankle instability (5 injured subjects) or control group (11 uninjured subjects). All subjects underwent performance tests (Yo-Yo Intermittent Recovery test, 20m Sprint, Shuttle run (10m×5), Arrowhead Agility test, One leg vertical jump, Figure 8 hop and Side hopping) . Results A significant relationship was found among the functional ankle instability index, Figure 8 hop (control group:9.2±0.6 sec, injured subjects:9.9±0.9sec, P≤0.05) and Side hop (control group:7.6±0.8sec, injured subjects:6.9±0.5sec, P≤0.02). No relationship was revealed between the functional ankle instability index and other performance tests. A significant relationship was found between the functional ankle instability index and Figure 8 hop (control group: 9.2±0.6 sec, injured subjects:9.9±0.9sec, P≤0.05), and also found between the functional ankle instability index and Side hop (control group:7.6±0.8sec, injured subjects:6.9±0.5sec, P≤0.02). No relationship was revealed in the other performance tests. **Discussion** Figure 8 hop seems to force a rotational stress on the ankle joint and lower leg (Carrie et al., 2005). Side hop test did not reveal a relationship with functional ankle instability. It is hypothesized that functional ankle instability affects the movement to the front direction more than the movement to the side direction. Acquisition of this movement is considered to be a measure of the recovery condition for athletes with functional ankle instability References Junge A, Dvorak J. (2007). Br J Sports Med. 41 Suppl 1, 3-7. Ekstrand J, Tropp H. (1990). Foot Ankle. 11(1), 41-44. Docherty CL, Arnold BL, Gansneder BM, Hurwitz S, Gieck J. (2005). J Athl Train. 40(1), 30-34. Contact Keigo Oda, kg-oda@sendai-u.ac.jp

### THE INFLUENCE OF MODERATE INTENSITY EXERCISE IN WATER ON ARTERIAL STIFFNESS DURING RECOVERY PERIOD

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**Introduction** It is well known that physical exercise affects arterial stiffness. Moderate intensity aerobic exercise on land leads to a transient decrease in arterial stiffness (Hefferman et al., 2007; Nogami et al., 2011). However, there have been few studies on the effects of exercise in water on arterial stiffness. Therefore, we investigated the effects of acute moderate intensity exercise in water on arterial stiffness. **Methods** Seven healthy males (age: 27.4 +/- 10.6 years, height: 172 +/- 6.2 cm, weight: 68.1 +/- 6.7 kg; mean +/- SD) participated in this study as the subjects. They separately completed both 10-min walking in water (WW trial; at a swimming pool, about 110 cm deep, 30 degrees C) at a pace of 75 steps/min (velocity: 46.9 m/min) and that on land (WL trial; at the poolside) at a pace of 150 steps/min (velocity: 93.8 m/min). These trials were followed by 15min recovery period on land. The brachial-ankle pulse wave velocity

(baPWV) and blood pressure were measured at rest, immediately after the exercise, at 10min postexercise, and at 15min postexercise while supine. These data were obtained in both trials on a makeshift bed placed at the poolside. The heart rate (HR) was measured in the same postexercise period and also during the exercise. Results and Discussion The baPWV of WW trial significantly decreased at 10 and 15min postexercise compared to the resting value (rest: 1,232 +/- 91, 10min: 1,123 +/- 111, 15min: 1,151 +/- 132 cm/sec;  $P < 0.05$ ). In addition, there was a significant difference between WW trial and WL trial at 10min postexercise (WW: 1,123 +/- 111, WL: 1,219 +/- 129 cm/sec;  $P < 0.05$ ). At 10min postexercise of WW trial, a significantly lower ankle diastolic blood pressure was observed compared to the resting value and that of WL (rest: 75 +/- 8, WW: 69 +/- 7, WL: 73 +/- 6 cm/sec). The HR during exercise was significantly higher in WW than WL trial (at the end of exercise, WW: 132 +/- 12, WL: 120 +/- 9 bpm). Although there is some difference in exercise intensity based on HR, it was considered that moderate intensity exercise in water elicited a distention of peripheral arteries during the recovery period compared to exercise on land. Therefore, it is suggested that this type of short-time exercise in water could be effective in lowering arterial stiffness (by baPWV), at least temporarily. References Hefferman et al. (2007). *Int J Sports Med.* 28, 197-203. Nogami J et al. (2011). *Jpn J Phys Fitness Sports Med*, 60(3), 269-277. Contact Takeshi Matsui (t-matsui@haruka.otemon.ac.jp)

## Training and Testing

### ORTHOCLINOSTATIC TEST AS A METHOD OF FITNESS LEVEL ASSESSMENT IN ATHLETES

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**Introduction** Achieving high sport result demands the verge of human physical abilities. But the way to the peak of sport career is long and unpredictable. The aim of the study was to determine the effects of different fitness level athlete organism adaptation in environment and to physical activity. Methods 20 athletes (12 females and 8 males, cross country skiers) aged from 10 to 20 with different fitness levels were undergoing an active orthoclinostatic test (supine position 1 during 3 min– standing during 3 min–supine position 2 during 3 min). During the test the hemodynamic monitoring with MARG 10-01 'Microlux' based on impedance cardiography provided us the data of electrocardiogram, automatically registered by beat-to-beat record. Heart rate (HR) and correlation rhythmogram (set of points which have coordinates defined by two adjacent cardiointervals values RRI and RRI+1) were under consideration. Results HR dynamics in orthoclinostatic test was 65-86-70 for novice with 1 or 2 years of sport experiences, 63-80-63 with 3 years of sport experiences, intermediate trainees had 58-70-55 while advanced athletes were close to 48-62-45. The correlation rhythmogram in supine position 2 changed from "cloud" to "dot" through "dense cloud" according to age of sport experience. Discussion Correlation rhythmogram method is used in different body position with special attention for the transient periods as it allows estimating participation of parasympathetic and sympathetic systems in HR regulation and also speed and quality of this regulation. Comparison of organism reactions while active orthoclinostatic tests revealed that athletes with 1 or 2 years of sport experience demonstrate the strong reaction of HR while transient into standing position. After returning to supine position 2 HR of novices in sport was higher than in initial supine position 1. Positive changes in adaptation as a rule appear in the end of the third year of sport trainings: HR in supine position 2 (HR3) tended to HR1. Athletes (4-7 years of sport experience) have adequate adaptation reaction in orthoclinostatic test similar to reaction on physical workload: the HR rise is moderate. Advanced athletes have professional sports reaction in orthoclinostatic test: HR3 is even lower than HR1. Correlation rhythmogram specifies HR reaction in orthoclinostatic test: the longer the experience in sport, the less R-R intervals dispersion at rest and transient ("cloud") and the shorter is the period of HR getting stabilized. Thus, according to athlete organism orthoclinostatic test reaction indicators (HR changing and "cloud" sizes in correlation rhythmogram) one can judge about the fitness level of young sportsmen and adjust the physical workload in correspondence to athletes' physiological readiness to train hard. Contact tarbeevaa92@mail.ru

### INDIVIDUALIZATION OF TRAINING PROCESS OF CROSS-COUNTRY SKIERS OF 12-14 YEARS

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**Introduction** During training process planning of children of 12-14 years it is necessary to consider uniformity and irregularity of organism physiological development in pre-puberty and puberty period. It is recommended to start going in for cross-country skiing at the age of 9-10 years. So at the age of 12-14 years there is a period of initial sport specialization (the beginning of specific training). Modern cross-country skiing is a very physically-demanding sport, requiring unique combination of endurance and strength. The purpose of the research was to suggest an informative and available testing method for diagnosis of cardiovascular and muscular systems development in order to individualize training process of cross-country skiers 12-14 years old. Methods Incremental test was held without preliminary warm-up on a treadmill which design allows to adjust running speed up to 26 km/h. Initial speed was 4 km/h. Each 2 minutes the speed of running was increased gradually (step by step) by 2 km/h. Physical work was performed to the full. Heart rate monitoring with GPS (Forunner 310XT) was used during the test and 5 minutes after it for recovery recording. Young cross-country skiers, 12-14 years old, with 1-2 years of sport experience took part in the experimental testing several times a year. Results According to HR-curves during the incremental test all athletes were divided into 3 groups: with muscle development prevalence (athletes with high HR during low intensity running), cardio development prevalence (athletes whose HR at the highest speed was lower than 180 bpm) and balanced muscle-heart development. Discussion Athletes with muscle development prevalence need to choose an aerobic orientation of training process. It is recommended to increase a number of low intensive (HR= 120±10 bpm) aerobic trainings and use HR monitoring during trainings in order not to exaggerate HR limits especially at long duration workouts. Athletes with well developed cardiovascular system should pay more attention to low and high intensity specific strength trainings. When forming training groups it is necessary to take into account a biological level of human organism development and individualize the physical workload in correspondence with athlete' physiological readiness to train in cross-country skiing. Contact tarbeevaa92@mail.ru

### PHYSIOLOGICAL DEMANDS OF AMATEUR MIXED MARTIAL ART FIGHTING

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**Purpose:** To quantify in-competition physiological loads of amateur mixed martial art (MMA) fighting. **Methods:** Ten male amateur MMA fighters (Age: 27.3 ± 3.3 y; Mass: 79.5 ± 0.5 kg; Height: 1.77 ± 0.04 m) training 9 ± 4 hours per week (strength 1 ± 1 h; aerobic 7.5 ± 3.5 h; anaerobic 0.1 ± 0.2 h), were filmed during 3 x 5min competitive rounds. Notational analysis was performed on the video-recordings from

the referee head-mounted camera (Go Pro, USA). This quantified standing punches including elbows thrown, kicks (including knees) attempted and respective percentage of each landed, furthermore accumulated time standing, clinching (standing grappling) and grappling (grappling and wrestling on the ground) were calculated. Heart rate (Polar, Finland) was measured during the post-round 1-min rest period, while the fighters perceived exertion (RPE) and earlobe sampled blood lactate (Lactate Pro, Arkray, Japan) were taken immediately post fight. Results: Similar heart rates were recorded ( $176 \pm 7$ ,  $175 \pm 14$ ,  $177 \pm 11$  beats.min) after each of the three rounds respectively; with the peak heart rate at  $92 \pm 6\%$  of age predicted maximum. The post bout blood lactate (taken within 3 minutes)  $12.0 \pm 2.8$  m.mol.L<sup>-1</sup> and RPE  $16 \pm 1$  a.u. values are in agreement with those found after competition ( $10.2 - 20.7$  m.mol and  $13-19$ , respectively) by Amtmann et al, 2003. While  $39 \pm 18$  punches were thrown per round, only  $20 \pm 11$  or  $47 \pm 20\%$  of these were landed. In comparison,  $11 \pm 7$  kicks were attempted, with a similar  $48 \pm 20\%$  ( $5 \pm 5$ ) of these striking the opponent. The fight time spent standing, clinching and grappling was  $38.5 \pm 17.6$ ,  $21.2 \pm 11.5$  and  $40.3 \pm 23.1\%$ , respectively. Conclusions: The proportionally higher amount of time spent fighting while standing and grappling on the floor indicates a higher priority training need for these components of fighting technique. This research may help develop training protocols that produce similar lactate and RPE responses to those found in athletes competing in amateur MMA. References: Ammann JA, Ammann KA, and Spath WK. Lactate and rate of perceived exertion response of athletes training for and competing in mixed martial arts event. *J Strength Cond Res* 22: 645-647, 2003

### EFFECT OF DETRAINING ON PHYSICAL FUNCTION AND EXECUTIVE FUNCTION AMONG ACTIVE ELDERLY

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Introduction Moving from sedentary to active way of life may help to delay Age-related cognitive impairment (Sherder et al., 2014), even more if Physical Activity (PA) implies a special emphasis on cognitive stimuli (Rebok, 2007). Multicomponent, enriched-environment, programs are usually prescribed among elderly (Cadore et al. 2014), expecting that the effects of PA on executive function will be later transferred to Daily Life Activities (DLA). On the other hand, if the PA programs reach a minimum of ten sessions, cognitive gains are expected to last from three to six months (Kelly et al., 2014), but relying on the type and doses of exercise, the detraining period which follows can be very deleterious, especially in this population. Yazigi & Armada-da-Silva (2008) concluded that physical function impairment due to detraining was bigger the older the population, but little is known about detraining and cognitive impairment. Objectives The present study aims to analyze the negative effects of detraining in a group of active Elderly, comparing Functional Capacity and Executive Function. Elderly were tested at the end of nine-month of a multicomponent and cognitive functional-training program, and 4 months later. Methods 16 women and 2 men ( $71.26 \pm 5.19$  years) completed the Stroop Test, the Time Up&Go Test (TUG) and the Six Minutes Walk Test (6MWT). T-test for related samples were conducted (Student and Wilcoxon) and the percentage of the differences was also considered. Results Detraining leads to a significant impairment only in Body composition and Physical Function ( $p < 0.05$ ): an increase in Weight ( $3.94\%$ ) and Fat Mass ( $11.30\%$ ), and a worsening in time (TUG:  $4.22\%$ ) and distance (6MWT:  $-3.78\%$ ), with no significant impairment on Executive Function. Discussion Similarly to Kelly et al. (2014), our results confirm that cognitive capacities in healthy elderly remain for a period of time, but not the physical fitness. One of the main aims of exercise training would be to keep physical fitness since it is a key factor in the maintenance of Executive Function (Yogev-Soligman, 2008) and ADL. REFERENCES: Cadore, E.L., Casas-Herrero, A., Zambom-Ferraresi, F., Idoate, F., Millor, N., Gómez, M., Rodríguez-Mañas, L., Izquierdo, M. (2014). Age. 36(2), 773-785 Golden, C.J. (1978). Stroop and Color Word Test. Chicago: Stoelting Co. Kelly, ME.; Loughrey, D.; Lawlor, BA.; Robertson, IH.; Wlasek, C.; Brennan, S. (2014). *Ag Res Reviews*. 15,28-43. Rikli, R.E. y Jones, C.J. (2012). *Senior fitness test manual* (2nd ed.): Human Kinetics. Scherder, E.; Scherder, R.; Verburgh, L.; Königs, M.; Blom, M.; Kramer, A.F.; Eggermont, L. (2014). *American J Ger Psych*. 22(8), 782-791 Rebok, GW.; Carlson, MC.; Langbaum, JBS. (2014). *J Geront: SERIES B*,62(II), 53-61. Yázigí, F. G., & Armada-da-Silva, P. A. (2008). *Med Sci Sports Ex*. 40(5), 10-10 Yogev-Soligman, G.; Hausdorff, J.M.; Giladi, N. (2008). *Mov disor*. 23(3), 329-342.

### CONSTRUCT VALIDITY OF THE PHYSICAL ACTIVITY QUESTIONNAIRE FOR ADOLESCENTS : MAXIMAL OXYGEN UPTAKE CRITERION.

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Introduction: The Physical Activity Questionnaire for adolescents (PAQ-A) is a cost-effective tool to assess physical activity (PA) patterns during adolescence and it has been widely used in research and field settings. Convergent validity of PAQ-A has been confirmed in several countries (Bervoets et al., 2014; Janz, Lutuchy, Wenthe, & Levy, 2008; Martinez-Gomez et al., 2009). However, the construct validity has often been overlooked. Therefore, the aim of this study was to analyze the construct validity of PAQ-A, using maximal oxygen uptake as criterion. Methods: One hundred and seventy-eight ( $n=99$  boys,  $n=79$  girls) adolescents ( $14.2 \pm 1.9$  years,  $21.1 \pm 4.1$  BMI) participated in this study. A PA score was estimated by PAQ-A and additionally a sport history was recorded. BMI, waist circumference (WC) and fat mass percent (FMP) were assessed by anthropometric measurements as adiposity markers. Aerobic fitness (VO<sub>2</sub>Max) was assessed by a progressive continuous test (Chester Step Test). Associations between PA-score and criteria were analyzed by Spearman correlations; a one-way ANOVA was conducted to detect differences between each item level from the PAQ-A; independent sample t tests were used to compare values between boys and girls, and athletes and non-athletes. Results: The results showed moderate significant positive correlations between VO<sub>2</sub>Max and the PAQ-C for total score ( $\rho = 0.28$ ,  $P < 0.01$ ) and items 5, 6, 7 and 8 ( $\rho = 0.24$ ;  $\rho = 0.25$ ;  $\rho = 0.22$ ;  $\rho = 0.25$ , all  $P < 0.05$ ; respectively). Adolescents who were enrolled in competitive and organized sport practice had higher scores on the questionnaire (2.8 vs 2.5 average score) as well as higher VO<sub>2</sub>Max values (37.4 vs 34.2 ml/kg/min). Discussion: Our data confirm the PAQ-A had acceptable construct validity when using VO<sub>2</sub>Max as criterion. Moreover, our results suggest that information from some items could be more related with some health markers than others. References: Bervoets, L., Van Noten, C., Van Roosbroeck, S., Hansen, D., Van Hoorenbeeck, K., Verheyen, E., . . . Vankerckhoven, V. (2014). Reliability and Validity of the Dutch Physical Activity Questionnaires for Children (PAQ-C) and Adolescents (PAQ-A). *Arch Public Health*, 72(1), 47. doi: 10.1186/2049-3258-72-47 Janz, K. F., Lutuchy, E. M., Wenthe, P., & Levy, S. M. (2008). Measuring activity in children and adolescents using self-report: PAQ-C and PAQ-A. *Medicine and Science in Sports and Exercise*, 40(4), 767-772. doi: 10.1249/MSS.0b013e3181620ed1 Martinez-Gomez, D., Martinez-de-Haro, V., Pozo, T., Welk, G. J., Villagra, A., Calle, M. E., . . . Veiga, O. L. (2009). [Reliability and validity of the PAQ-A questionnaire to assess physical activity in Spanish adolescents]. *Rev Esp Salud Publica*, 83(3), 427-439. Contact: benitez@uma.es This work was supported by the Spanish Ministry of Education, Culture and Sport (AP2010-0583), Spanish Ministry of Economy and Competitiveness (DEP2011-30565) and the University of Málaga (Campus of International Excellence Andalucía Tech).

## PREDICTORS OF MOTOR COORDINATION PERFORMANCE IN PREPUBERTAL CHILDREN

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**INTRODUCTION** Motor development is apparently related to involvement in physical activities and sport participation and it is believed that motor coordination is directly associated with motivation for physical activity (Rivilis et al., 2011). The aim of this study was to examine the association of anthropometric and maturation predictors on motor coordination performance in prepubertal children. **METHODS** The sample included 128 children (males: n=61; females: n=67) aged 8.0-8.9 years. The battery comprised stature (S), body mass (BM), sitting height (SH), waist circumference (WC) and measurements needed to estimate fat mass (FM), fat-free mass (FFM) and to percentage of predict mature stature (%PMS). Body mass index (BMI) was calculated. The Körperkoordinationstest für Kinder (KTK) was also used. Initially, descriptive analysis and Kolmogorov-Smirnov were performed. Sex differences were reported by 'd' of Cohen and interpreted as recommended by Hopkins et al. (2009). Multiple linear regression (backward method) was used to estimate the relative contributions of anthropometric and maturation predictors to variation in KTK test by sex. **RESULTS** Comparisons between sexes were significant for maturation (males: 74.7%; females: 80.5%) and among anthropometric variables, sex differences were uniquely significant for FFM (males: 23.4Kg; females: 21.5Kg). Among the KTK battery, sex differences was trivial for two items: walking backward (d=0.16) and moving sideways (d=0.02); and small for the other two tests: jumping sideways (d=0.20) and hopping for height (d=0.44). The predictor variables explained 29% of the variance in the KTK for males (BMI and WC were the selected predictors in the model, positive and negative, respectively) and 23% for females (S and BMI as significant negative predictors, SH as significant positive predictor). **DISCUSSION** Interpretation of sex differences needs to be considered in the context of growth, maturation and the familial and ecological predictors principles may be central in studies devoted to sex differences in the transition from childhood to pubertal years.

## TRUNK MUSCLES ACTIVITIES DURING FREESTYLE SWIMMING STROKE

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**Introduction** In recent years, trunk stability has been thought to be important in swimming performance. In fact, a lot of training for improvement of the trunk stability is taken in. However, the trunk muscle activities during swimming have not been determined yet. If the timing of the trunk muscle activity is clarified, a more effective trunk training can be offered. Therefore, the purpose of this study was to observe the trunk muscle activities during freestyle swimming. **Methods** The subjects included in this study were seven male college elite competitive swimmers. Sixteen EMG signals were obtained using disposable surface electrodes and two trunk muscles activities were analyzed in this study. Pairs of electrodes were positioned onto the internal oblique (IO) and external oblique muscle (EO) on the right side of subjects, in the direction of the muscle fibers. All of the subjects were required to perform freestyle swimming at a moderate speed to approximately 15 m from the swimming pool wall. The stroke cycle was divided into 10 equal time intervals and EMG activities during each interval were normalized compared to the peak signal value which is estimated as 100 percentage. **Results** The muscle activities of the IO and EO were maximized (IO:57.3%, EO: 59.5%) at approximately 50% of the stroke cycle when an ipsilateral hand passed the deepest position. **Discussion** This might be the first research which measured the EMG of trunk muscles during swimming. We analyzed the muscle activation period mainly in this study, and revealed that the peak of the IO and EO activities were observed when a hand passed the deepest position. During the freestyle strokes, hand drawing speed might be maximized at the middle phase of pull-through motion and the propulsion power to the swimmer's body might be maximized. If the trunk stability is insufficient, propulsion power might not be sufficiently transmitted to the body, so we think that the elite swimmers activate their trunk muscles at that period in order to swim faster. **Conclusion** During the freestyle swimming strokes, the activities of the IO and EO muscles peaked at the middle phase of pull-through motion.

## EFFECTS OF ECCENTRIC STRENGTH TRAINING IN RUNNING ECONOMY OF RECREATIONAL ENDURANCE RUNNERS

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**Introduction** Several studies showed the effects of combined strength and endurance training on endurance performance and running economy (RE). However, few studies investigated specifically the effects of eccentric strength training. Aim of this research was to measure variation of RE after a combined eccentric strength-endurance training versus low or high intensity endurance training programs. **Methods** Twenty-nine well trained recreational runners (average age 35-55y; V'O<sub>2</sub>max around 50 ml/min/kg) were randomized in 3 training programs: combined eccentric strength-endurance (EST), low intensity endurance (LIT), high intensity training (HIT). Each group performed 8-week of training, 3 times a week; training volume (time x intensity) was accurately equalized among the groups. Reference Velocity (RV) as the medium speed between the first and the second ventilatory threshold was used to identify individual training intensity. RV ranged 95-140% for HIT and 70-105% for LIT and EST groups respectively. EST group, in addition to LIT program, performed once a week, 4 sets of 7 repetitions of Yo-Yo Leg Press (Yo-Yo Technology Stockholm Sweden). Before and after training each runner underwent metabolic measurements (Cosmed Quark, Italy) on a treadmill for determination of V'O<sub>2</sub>max and RE at three submax steady state speeds. Lower Limb Free Fat Mass (LLFFM) were measured by DXA (Holometric, USA) and leg-press 1RM (Technogym, Italy). Data were analysed by two way ANOVA and significance level was set at p<0.05. **Results** The combined endurance and strength training (EST group) produced significant improvements in RE (pre 4.5±0.3 J/m, post 4.3±0.4 J/m (p ≤ .05) and 1RM leg press (pre 143.8±35.8 kg, post 162.4±37.3kg (p ≤ .05) while no change in RE was found in HIT (pre: 4.6±0.3, post 4.6±0.4 J/m-l) and in LIT (pre: 4.2±0.5, post 4.2±0.3). V'O<sub>2</sub>max and LLFFM. Did not show significant modification in any groups. **Discussion** The data from the present study show a significant increase of muscle strength with associated reduction of RE in EST group with no concomitant changes in the V'O<sub>2</sub>max and in the lower limb muscle mass. These adaptations seem to indicate that short duration eccentric training (one bout/week for about 20min) produces changes in structural muscle characteristics (fibers, architecture) and intra and inter muscular coordination allowing a reduction in RE in well trained recreational runners without any reduction in aerobic power. References Turner, AM, Owings, M, and Schwane, JA. J Strength Cond Res 17: 60-67, 2003. Tesch PA & HE Berg. Int J Sports Med 18:S322-324 (Suppl 4), 1997. Piacentini MF, De Ioannone G, Comotto S, Spedicato A, Vernillo G, La Torre A. J Strength Cond Res. 2013 Aug;27(8):2295-303 luca.festa@me.com

## THE RELATIONSHIP OF SHOULDER MAXIMAL EXTERNAL ROTATION RANGE OF MOTION ON BALL-THROWING SPEED IN YOUTH BASEBALL PITCHERS

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**Introduction** To pitch a baseball high rotational forces are needed. Repetitive pitching at high velocities leads to adaptations in the shoulder complex of the throwing arm. Several authors have documented that the throwing shoulder in overhead-athletes exhibits significantly more external rotation and significantly reduced internal rotation when compared to the non-throwing shoulder or to non-overhead-throwing athletes (Ellenbecker et al., 2002; Savers et al., 2014; Wilk et al. 2011). A lot of research into this subject has been done in relation to injuries. The purpose of this study was to see if there is a relation between maximal external rotation of the throwing arm and throwing velocity. **Methods** As a part of a larger study maximal external rotation range of motion of the throwing shoulder was measured using a digital inclinometer in a group of 61 Dutch male youth baseball pitchers. All participants were members of the six talent academies of the Dutch baseball federation and were playing in the Aspirant and Junior Elite League. Throwing velocity was measured using a radar gun and the average of ten subsequent throws was calculated. Measurements were taken in October at the end of the game season. Linear regression analyses were performed to explore the relation between maximal external rotation of the throwing arm and throwing velocity. **Results** The throwing velocity of this group of young pitchers was on average 67.6 (SD 6.2) miles per hour (mph) with a range of 54-80 mph. The average maximal degree of external rotation of their throwing arm was 116.1 (SD 19.8) degrees with a range of 44-169 degrees. Linear regression analysis showed that maximal external rotation was not significantly associated with throwing velocity (regression coefficient 0.008 mph/degree, 95% confidence interval [-0.073, 0.090]). Adding the age groups to the regression model did not change this finding substantially (regression coefficient 0.013 mph/degree, 95% confidence interval [-0.053, 0.078]). However, this final model showed that junior pitchers on average throw 7.6 mph (95% confidence interval [5.0, 10.2]) faster than aspirants. **Conclusion** The amount of maximal external rotation was not significantly related to the throwing velocity of youth baseball pitchers. **References** - Ellenbecker T.S., Roetert E.P., Baillie D.S., Davies G.J., Brown S.W. (2002). *Med Sci Sports Exerc.* 34(12), 2052-2056. - Savers E.L., Huxel Bliven K.C., Johnson M.P., Falsone S., Walters S. (2014). *Am J Sports Med.* 42(2), 430-436. - Wilk K.E., Macrina L.C., Fleisig G.S., Porterfield R., Simpson II C.D., Harker P., Paparesta N., Andrews J.R. (2011). *Am J Sports Med.* 39(2), 329-335. Contact f.van.dis@vu.nl

## THE DIAGNOSTICS OF ED ELEMENTS IN COMPETITIVE SPORT

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**Introduction** The verification of effectiveness and accuracy of used methods and their practical use in managing training and sports contests is a key element of training process management (Gabrys and Kosmol 2000, Neuman et al. 2005, Ozimek 2007, Zemkova 2008). The aim of this papers is to present the selected elements of diagnostics in competitive sport with special attention to the determination raining indicators in selected areas of motor preparation of team members of Polish volleyball of men. **Methods** The research included 9 members of Polish volleyball of men premier league (PlusLiga). The programme of the research was as follows: Warm-up. Psychomotorics on a large field (before and after effort) – a test evaluating reaction and orientation speed performed by legs on a field of 3 meters (a square; Fitro Agility Check). Evaluation of lower limbs (before and after effort) – tests: SQUAD JUMP, CMJ – Counter movement jump with and without backswing and DROP JUMP. Aerobic capacity – BIP TEST – every 3 min. increase in load and biochemical examination (K4b2 Cosmed; BIOSEN C-line). **Results** The results point to a direct aim of conducted research and determine the effect on the controlled indicators on the effectiveness of training, comparisons between participants, evaluation of oxygen consumption, determination of the kinetics of oxygen deficit and oxygen debt as well as determination of the level of lactate at different moments of effort. The results of this research provide direct information on the state of preparation and its possibilities related to the conducted control of training effects. **Discussion** Numerous questions related to success and failure of a sportsperson can be answered by a sports training diagnostician. What is more, comprehensive and systematic diagnostics supports both the work of a player and a trainer (Neuman et al. 2005, Ozimek, 2007). The scope of training control and its effect should include a wide range of observations. Their most important elements include: biochemical supervision, physiological supervision of anaerobic and aerobic capacity in laboratory conditions as well as conditions specific to a particular sports discipline, physical fitness and specialist preparation regarding power, force, speed, speed and strength endurance as well as the analysis of a sports training conducted in a training series (Gabrys and Kosmol 2000, Zemkova 2008). **References** Gabrys T., Kosmol A. /red./ (2000). Alma-Press. Neuman G., Pftzner A., Hottenrott K. (2005). Grada Publishing. Ozimek M. (2007). *Studia i Monografie nr 25*, AWF Krakow. Zemkova E. (2008). Slovenska olimpijska marketingova. Contact Mariusz Ozimek, mozime@poczta.onet.pl

## NEUROMUSCULAR AND CARDIOVASCULAR ADAPTATIONS IN RESPONSE TO A HIGH INTENSITY INTERVAL POWER TRAINING.

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**Introduction:** The aim of the present study was to examine the effects of a high-intensity interval power training (Power-HIIT) of 6 weeks on the aerobic and power performance. **Methods:** For this purpose, 29 healthy participants were recruited and randomly distributed in three different groups. One group performed traditional power training (TPT; n=10), the second group performed Power Training organized as a HIIT (PHT; n=10) and the third one serve as a control group (CG; n=9). During the power training sessions, subjects performed the following exercises: Bench Press, Rebound Jump, High Pull and all-out cycle-ergometer. In both training protocols, subjects were instructed to perform the exercises during 10 seconds at the maximal velocity using the optimal load for each exercise. The amount of work load (set and session volume, and velocity) and local muscular rest period (90 sec) were equated, however, the time between exercises was different (PHT: 15 sec.; TPT: 90 sec.). The training protocols differed in the organization of the exercises. Power-HIIT training was performed in a circuit training fashion and traditional one in a vertical way. In order to know the effects in the aerobic performance, maximal aerobic speed (MAS) was measured. In order to identify the effects on the power performance subjects performed a Wingate test, a counter-movement jump test (CMJ) and a power load curve in Bench press. A two way RM-ANOVA (time -pre vs. post- and group -PHT vs. TPT vs. CG- as factors) were used to test the effect of the different power training protocols. **Results:** The main results showed that after both power training protocols subjects increased significantly ( $p < 0.05$ ) the power production during the Wingate Test, the height and power reached during the CMJ and the peak power produced during the power-load curve. However, when analyzing the MAS only the PHT

group improved significantly ( $P < 0.05$ ). Discussion: Present results are in line with those findings that have previously demonstrated concurrent improvements in both aerobic and force parameters using heavy resistance circuit training (Romero-Arenas et al., 2013). Conclusion: Therefore, the current study shown that power-HIT is a time-efficient method to improve both aerobic and power performance. References: Romero-Arenas, S., Blazevich, A. J., Martínez-Pascual, M., Pérez-Gómez, J., Luque, A. J., López-Román, F. J., & Alcaraz, P. E. (2013). Effects of high-resistance circuit training in an elderly population. *Experimental gerontology*, 48(3), 334-340.

### EFFECTS OF A STRENGTH TRAINING SESSION ON RECOVERY AFTER AN EXERCISE-INDUCED MUSCLE DAMAGE: A RANDOMISED CROSS OVER STUDY

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**Introduction** In football, many eccentric actions are performed and lead to muscle damages. When two matches per week are played, the recovery period between these matches may be too short to fully recover. In this context, the ability to accelerate the return to the initial level of performance is major. Several hormones, such as growth hormone and testosterone play a major role in muscle regeneration (Goldspink, 2005; Schoenfeld, 2010). As some strength training session induces an increase of these hormones (Kraemer et al., 1990; Simao et al., 2013), this study was designed to analyse the effects of a strength training session after an exercise inducing muscle damage on the recovery kinetics. It was hypothesised that the strength training session improves the recovery kinetics. **Methods** In a randomised crossover design, subjects performed, at two separate occasions (control versus experimental conditions) on a one-leg exercise (dominant in one condition and non-dominant in the other condition), 5 sets of 15 eccentric contractions on the knee flexors. After this exercise-induced muscle damage, the subjects were allocated to the control condition (passive recovery) or the experimental condition, which consisted in performing an upper-body strength session. Creatine kinase, hamstring strength and muscle soreness were assessed immediately, 20h, 24h and 48h after exercise-induced muscle damage. **Results** Concentric strength at 120°.s-1, eccentric strength at 120°.s-1, isometric strength at 60° and muscular soreness was largely reduced ( $p < 0.001$ ;  $ES = 1.28$  to  $3.25$ ) at 20h, 24h and 48h after exercise-induced muscle damage. However, no difference was observed in the two conditions (control versus experimental;  $p > 0.05$ ,  $ES = 0.03$  to  $0.4$ ). **Discussion** The results failed to confirm the hypothesis, as no difference was found between the two conditions. The upper-body strength session, performed after exercise-induced muscle damage, does not accelerate the recovery process, but does not delay the recovery kinetics. **References** Goldspink G (2005). *Physiology*, 20, 232-238 Kraemer WJ, Marchitelli L, Gordon SE, Harman E, Dziados JE, Mello R, Frykman P, McCurry D, Fleck SJ (1990). *J Appl Physiol*, 69(4), 1442-50. Schoenfeld BJ (2010). *J Strength Cond Res*, 24(10), 2857-2872 Simão R, Leite RD, Fleury Fina Speretta G, Souto Maior A, Freitas de Salles B, Pessoa de Souza Junior T, Vingren JL, and Willardson JM (2013). *Appl Physiol Nutr Metab*. 38, 177-181 Contact Abd-elbasset.abaidia@etu.univ-lille2.fr

### RELATIONSHIPS BETWEEN DIFFERENT PHYSICAL FACTORS IN MALE SOCCER PLAYERS

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**Introduction:** In addition to technical and tactical skills, modern soccer players need to evolve physical capacities to succeed on high level. Soccer game analyses have shown that both sprinting abilities and endurance are important success factors. Other studies have shown a relationship between speed and leg-strength, and between balance and change of direction speed. The aim of this study was to investigate relationships between linear speed, change of direction speed, aerobic and anaerobic endurance, strength, power, flexibility and balance in male soccer players. **Method:** Eighty-two male soccer players (age:  $20 \pm 4$  years; weight:  $75\text{kg} \pm 9$ ; height:  $181\text{cm} \pm 6$ ; body fat:  $10.4 \pm 3.1\%$ ) from first, second and third level in the Norwegian league system participated in the study. All tests were performed during two following days. At day 1 all players performed 40 meter linear sprint (time measurements at 10, 20, 30 and 40 meters), 30m change of direction sprint and repeated sprint (8 x 20 meters, starting every 30 seconds). All running tests were performed at an indoor running track, and the times were measured using timing system (Brower, USA). In addition all players performed a 90 seconds anaerobic endurance jump test and a countermovement jump tests using a force plate (Kistler, Switzerland), at both legs and at single-legs. Moreover, all players performed a 5 repetition maximum (RM) squat test, a 1 RM bench press test, followed by a test of maximal repetitions of chins and in brutal bench. At day 2 all players underwent body composition analyses (InBody 720, Biospace), spirometry (Vyntus CPX, Jaeger, Germany) and maximal oxygen consumption test (Jaeger Oxycon Pro in mixing chamber mode, Jaeger, Germany). In addition hip, knee, ankle and hamstring flexibility and balance were tested. NB! All analyzes will be completed in late March. Results and discussion will be forwarded when the analyzes are done. Contact: mkr@hib.no

### PHYSICAL CHARACTERISTICS AND GAME RELATED STATISTICS OF ELITE ADOLESCENT FEMALE BASKETBALL PLAYERS

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**Introduction** Optimal performance in basketball is highly complex because it requires a combination of technical and tactical abilities and a high degree of physical fitness (Ben Abdelkrim et al., 2010; Ziv & Lidor, 2009). The main aim of this study was to evaluate the relationship between physical fitness and game-related performances in young elite basketball players. **Methods** Twenty-three young, female, elite Spanish basketball players (age:  $16.2 \pm 1.2$  years, mass:  $71.6 \pm 10.9$  kg, stature:  $1.82 \pm 0.07$  m) participated in the study. The average physical fitness performance scores of the pre and post – season testing were used as the representative values for subsequent analyses: aerobic power (yo-yo intermittent test), speed (¼ basketball sprint test), agility (T-test), anaerobic capacity (line drill), repeated sprint ability (10 x 30 m), strength (leg and bench press) and power (jumping and throwing abilities). Anthropometric variables were also measured. To evaluate game performance, statistical data of games played and minutes, points, rebounds, assists, steals and blocks per game were identified during every competitive match of one season and the data were averaged. **Results** Only two game-related performance variables correlated significantly ( $p < 0.05$ ) with physical fitness test performance. Assists per game correlated with: vertical jump ( $r = 0.44$ ), speed ( $r = 0.65$ ), agility ( $r = 0.70$ ), anaerobic power ( $r = 0.68$ ), repeated sprint ability (mean and best) ( $r = 0.62$  and  $r = 0.64$ , respectively) and aerobic power ( $r = 0.66$ ). Steals per game correlated significantly with: speed ( $r = 0.48$ ), agility ( $r = 0.48$ ), anaerobic power ( $r = 0.51$ ), repeated sprint ability (best) ( $r = 0.47$ ) and aerobic power ( $r = 0.56$ ). **Discussion** Our results suggest that superior aerobic and anaerobic power, speed and agility and jump capacity are related to some key game-related performance measures. There is a scarcity of



research available investigating the relationship between game-related performance and physical fitness capacity in basketball players. To the best of our knowledge, there is one similar study in the literature. McGill et al. (2012) showed that standing broad jump and lane agility time were significantly correlated with some game-related performance measures (e.g. minutes, assists, rebounds) in male basketball players. Our finding indicates that it may be of interest to identify and develop physical fitness characteristics that are associated with some game-related statistics in order to improve game success. References McGill, S. M., Andersen, J. T., & Horne, A. D. (2012). Predicting performance and injury resilience from movement quality and fitness scores in a basketball team over 2 years. *The Journal of Strength & Conditioning Research*, 26(7), 1731–1739. Ziv, G., & Lidor, R. (2009). Physical attributes, physiological characteristics, on-court performances and nutritional strategies of female and male basketball players. *Sports Medicine*, 39, 547–568.

#### **A FOUR WEEK ANALYSIS OF RECOVERY STATUS IN KOSOVAN YOUTH SOCCER PLAYERS**

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The trend to increase training loads has to be counterbalanced by proper recovery strategies (Tessitore et al 2007, 2008). This fact requires the awareness of how external training loads can affect the recovery status of athletes. Therefore, this study aimed to investigate the recovery status of young soccer players during four weeks of in-season, characterized by training sessions and two weekly match conditions (one match (W1match) and two matches (W2 match) per week, respectively). Hence, in order to examine differences between the two conditions, if any, the players' recovery was measured before each training and match. Thus, 22 Kosovan soccer players belonging to the "2 korriku" (Pristina, Kosovo) youth team (age:  $14.5 \pm 0.30$  yrs, height:  $174 \pm 7.93$  cm, weight:  $60.1 \pm 7.95$  kg) participated in this study. Consequently, individual recovery data were collected during 12 training sessions and before six matches by means of a modified TQR questionnaire (based on 10 point scale), which was translated in Albanian language to facilitate the players' comprehension. In addition, a training log was administered for each training session, in order to collect information regarding the loads imposed to the players. Surprisingly, no significant differences were found in players' recovery status ( $p = 0.63$ ) between W1match and W2match conditions ( $6.50 \pm 0.91$ , and  $6.19 \pm 1.01$ , respectively). Moreover, general results of the current study showed that players' recovery was rather similar (slightly higher) compared with results provided by Brink et al. (2010a & 2010b). Furthermore, according to the individual scores gathered by the questionnaires submitted before each game, our players felt a recovered status, testified by their answers which scored at least a point of 7 ("very good recovery") or above. Additionally, in the light of findings of the current study, it can be speculated that players were strictly following the guidelines received by their coach about how to manage eating, sleeping, drinking and resting after training sessions and matches. Finally, training log results demonstrated that a complete exclusion of strength and conditioning was implemented as a coach's strategy during the weeks scheduled with two matches, in order to avoid high physical stress during the last training period before the play-off phase competition. References Tessitore et al. (2007). *J Strength Cond Res*, 21(3), 745-750. Tessitore et al. (2008). *J Strength Cond Res*, 22(5), 1402-1412. Brink et al. (2010a). *J Strength Cond Res*, 24(3), 597-603. Brink et al. (2010b). *Br J Sports Med*, bjsports69476.

#### **ROWING ERGOMETER 30 MINUTES ALL-OUT TEST AS A PREDICTION OF THE VENTILATORY TRESHOLD**

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Introduction For the purpose of properly dosing the training load in rowing sports, the value of the ventilatory threshold (VT) and maximal oxygen consumption are most often used. Laboratory measurements of functional abilities, with which specifically measured values of these characteristics are obtained, are not available to everyone, due to both financial reasons and lack of facilities. Therefore, the aim of this study is to find the relation of intensity of ventilatory threshold obtained in the laboratory to the average split time achieved on the 30 minutes all-out test. Methods The analysis was performed on a group comprised of 44 rowers of the Croatian national team. Measurement of  $VO_{2max}$  was done in a laboratory and the ventilatory threshold was derived from this. The same rowers performed the standardized 30 minutes all-out test on the rowing ergometer. In addition to the total distance travelled, the average split time was recorded. Both tests were carried out within a time period of two weeks. Descriptive analysis, t-test and regression were processed using the statistical package Statistica 11. Results The values of the intensity of work on the ventilatory threshold are shown by the 500 meters split time (VT split), which also shows the average intensity during performance of the 30 minutes all-out test. Work intensity of the 30 minutes all-out test was  $1:44.8 \pm 4.0$  (mean  $\pm$  standard deviation), while the VT was reached on values of  $1:45.2 \pm 4.7$ . Evaluation of equality of arithmetic means of the two groups gave the t-value = 0.44;  $p = 0.66$ . Regression analysis indicated a statistically significant correlation between these two parameters ( $r = 0.8002$ ;  $p = 0.0000$ ) and formed the regression equation  $VT_{split} = 7.3296 + 0.934 * X$ . Discussion The results indicate that there is no statistically significant difference between the data measured by the two tests. The statistically significant and high correlation indicates that a large part of the variability of the ventilatory threshold can be explained by the result of the 30 minutes all-out test. That leads us to the conclusion that the average split time on the 30 minutes all-out has a high prediction, and that the regression equation can be used with very small risk for approximating the ventilatory threshold. References Bourdon PC, David AZ, Buckley JD (2007). *JSAMS*, 12 (1), 205-211 Firat A (2014). *Journal Human Kinetics*, 41, 133-142 Mikulic P (2009). *JSCR*, 23 (6), 1851-1857 Tokmadikids SP, Leger LA, Piliandis TC (1998). *Eur J Appl Physiol*, 77, 333-342

#### **RELIABILITY OF SIDE-HOP LIMB IMBALANCE RATIO**

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Introduction Although Side-hop test (SHT) has been commonly used to evaluate functional performance after lower limb injuries (Itoh et al. 1998; Docherty et al. 2005), some important metric characteristics have not been evaluated yet. Therefore, the primary aim of the study was to determine the number of measurements (i.e., sessions/trials) necessary to obtain a stable limb imbalance ratio assessed through limb symmetry index (LSI). The secondary aim was to examine the absolute and relative reliability of LSI. Methods Fifteen subjects performed 3 trials of SHT (jumping 20 times from side-to-side over two lines set 30 cm apart), within 6 sessions separated with 2 days of rest each. LSI was calculated as a percentage ratio of the nondominant and dominant limb score. Within-within ANOVA was used to investigate the within and between day differences in LSI. Absolute within and between day reliability was evaluated with the intraclass correlation coefficients (ICC), while absolute reliability was assessed through the standard error of measurement (SEM), presented as percent of the mean value. SEM was further used to determine minimal detectable changes (MDC) for LSI. Results There was no difference in LSI both

within day ( $F=0.92$ ;  $p=0.48$ ) and across the sessions ( $F=0.15$ ;  $p=0.86$ ). Although relative reliability (both between and within day) was generally moderate (ICC ranged from 0.36 to 0.74), the absolute reliability was exceptionally high (all SEM below 5%), while within day MDC ranged from 10.2-18.2%. Between-day MDC was 9.1%. Discussion The comparison across the sessions revealed that LSI was stable both across the days and between sessions, suggesting that SHT could be routinely used without previous familiarization sessions. It also appears that LSI could have the property of low relative and high absolute reliability, suggesting that LSI as a measure of imbalance ratio should be used and interpreted with caution. Future studies should examine possible strategies designed to increase the reliability of LSI and compare it across different populations to ascertain the clinical application of LSI obtained from SHT. References Itoh, H., Kurosaka, M., Yoshiya, S., Ichihashi, N., & Mizuno, K. (1998). Evaluation of functional deficits determined by four different hop tests in patients with anterior cruciate ligament deficiency. *Knee Surgery, Sports Traumatology, Arthroscopy*, 6(4), 241-245. Docherty, C. L., Arnold, B. L., Gansneder, B. M., Hurwitz, S., & Gieck, J. (2005). Functional-performance deficits in volunteers with functional ankle instability. *Journal of athletic training*, 40(1), 30.

### **A RELATIONSHIP BETWEEN SINGLE LEG TASKS AND SIDESTEP CUTTING IN MALE RUGBY PLAYERS -LATERAL HOP AND HOP-AND-SIDESTEP-**

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**Introduction** Many non-contact anterior cruciate ligament (ACL) injuries occur during sidestep cutting in rugby players. Knee valgus moment is viewed as an important predictor of non-contact ACL injury risk. Screening tests for the risk of non-contact ACL injuries tend to focus on knee valgus moment and angle during landing tasks on both legs. But the injuries are predominantly distributed to a single leg in sidestep cutting. We required simple and easy clinical screening tests based on single leg tasks. The purpose of this study was to investigate whether there is a relationship between lateral hop, hop-and-sidestep, drop vertical jump (DVJ) and sidestep cutting in male rugby players. **Methods** Seven male rugby players (23.7±1.5 years, 170.4±3.4 cm, 75.3±7.5 kg) participated in this study. Lateral hop and hop-and-sidestep were included in single leg tasks. Lateral hop was defined as single leg hop toward the same side of the standing leg. Hop-and-sidestep was defined as single leg hop forward, landing with the same leg, and cutting to the opposite direction of the standing leg. Participants performed lateral hop, hop-and-sidestep, DVJ and sidestep cutting tasks. A three dimensional motion analysis system featuring ground reaction force was used to determine kinematics and kinetics of both legs (7 right legs, 7 left legs). Peak knee valgus angle and moment during tasks were calculated. Peak knee valgus moment was normalized to weight. **Results** There was no significant difference in peak knee valgus angle between tasks. Peak knee valgus moment in sidestep cutting (1.3±0.5 Nm/kg) was greater than in DVJ (0.5±0.2 Nm/kg) and lateral hop (0.4±0.3 Nm/kg). There was no significant difference in peak knee valgus moment between hop-and-sidestep and sidestep cutting. Strong correlation was found in peak knee valgus moment between DVJ and sidestep cutting ( $r=0.64$ ,  $P<0.05$ ), lateral hop and sidestep cutting ( $r=0.89$ ,  $P<0.01$ ), and hop-and-sidestep and sidestep cutting ( $r=0.76$ ,  $P<0.01$ ). **Discussion** The results suggest that there are relationships between lateral hop and sidestep cutting, and also hop-and-sidestep and sidestep cutting in knee valgus moment. We believe lateral hop and hop-and-sidestep are simple and easy clinical screening tests based on single leg tasks. Contact E-mail: wtr0804@hotmail.co.jp

### **RELATIONSHIP BETWEEN THE JUDO FITNESS TEST AND LOWER SKELETAL MUSCLE POWER AMONG JAPANESE FEMALE JUDO PLAYERS**

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**Introduction** Judo is the martial art fathered by Jigoro Kano in 1882. He is called to 'the fatherhood of the judo' or 'the fatherhood of the Japanese physical education' in Japan. It was adopted formally at the Tokyo Olympic games in 1964 (men's only, the women's event was introduced at the Olympics in 1988). The Japanese judo is traditional well-known sports in the world. There are divided into seven classes weight divisions system (under 48kg, 48-52kg, 52-57kg, 57-63kg, 63-70kg, 70-78kg, and over 78kg), and it is 4 minutes for women's competition. Judo is the sport that throws an opponent at restriction time. Competitive judo can be described as a combative, high intensity sport in which the athlete attempts to throw the opponent onto partner back or to control partner during groundwork fight. It is necessary specific techniques and tactical skills with the support of good physical fitness. It was based on special qualities, and was contrived "the special judo fitness test" by Sterkowicz (1995), which test executor throws partners using the ippon-seoi-nage technique, as many times as possible. And then when the seoi-nage is performed, Mori et al (2011) are explaining necessity of the thigh muscles strength and power. The purpose of this study was to examine mutual relation measured by the special judo fitness test (SJFT) (Emerson et al, 2009; Franchini et al, 1998; Patrik et al, 2012; Sterkowicz, 1995) with blood lactate and heart rate and lower extremity muscular power by 30-s wingate anaerobic test (WAnT) (Bar-Or O, 1987). **Methods** Japanese female judo players were applied in this study obtained their parents' informed consent. SJFT and WAnT on mechanically braked cycle ergometer were used for evaluation. **Results & Discussion** Franchini et al shared Brazilian judo players with 3 categories (juvenile, junior, and senior) by the age and compared the SJFT. When it will be analyzed, neither the each SJFT item, nor blood lactate and heart rate were confirmed by the difference between three groups (Okawa et al, 2015, unpublished). A relation between the SJFT and the lower muscle power in the Japanese female judo players is announced. **References** Bar-Or O (1987). *Sports Med*, 4(6), 381-394. Emerson F, Fabricio V, Stanislaw S (2009). *Archives of Budo*, 127-129. Franchini E, Nakamura FY, Takito MY, Kiss MAPDM, Sterkowicz, S (1998). *Judo Information Site Research* [<http://judoinfo.com/research5.htm>]. Patrik D, Tatjana T, Sergey T (2012). *Seb J Sports Sci*, 6(4), 117-125. Sterkowicz S (1995). *Antropomotoryka*, 29-44. Mori E, Hamada H, Oyamada K, Fujita E (2011). *Sports training science*, 12, 9-13 (in Japanese). Contact Author's e-mail address: okawa@budo-u.ac.jp

### **RESEARCH ON PHYSICAL FITNESS CHARACTERISTICS OF TENNIS PLAYERS**

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In order to achieve top-level results in major matches domestically and abroad, continuous practice and building of physical fitness from the junior period is required. However, there is very little research into the correlation between playing ability and physical fitness. And so the purpose of this research was to examine items testing physical fitness which is beneficial to exercise and training and contribute to improving player ability in the future. The subjects were 98 boys and girls aged 9 to 22 whose game of specialization is tennis (61 boys, 37 girls). The measurement items measuring general physical fitness were standing long jump, long seat type body antelexion, sit-ups,

medicine ball throwing, and 3-minute shuttle stamina. Furthermore, as items measuring tennis-specific physical fitness, measurement items were 10m run, 505-agility test, pro-agility test, hexagon jump, and one-leg standing long jump. Analyzing the correlation between age and each measurement item of physical fitness showed a strong correlation with general physical fitness measurement items, but the correlation with tennis-specific physical fitness measurement items was weak or in some cases non-existent. Furthermore, players who showed high values in the tennis-specific physical fitness measurement items were also superior in playing ability. These facts suggest that these tennis-specific physical fitness measurement items may have the potential to measure physical fitness factors required in tennis players from a young age

### INDIVIDUAL HAEMOGLOBIN MASS RESPONSE TO ALTITUDE TRAINING AT 1800 M IN ELITE ENDURANCE ATHLETES

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**Introduction** Given the interindividual variability of haemoglobin mass (Hbmass) -responses to altitude training (Friedmann et al., 2005), one can speculate that despite the insignificant mean increase of Hbmass after altitude training at < 2000 m (Pottgiesser et al., 2009), there can be athletes with a substantial increase of their Hbmass even at < 2000 m. However, the assessment of individual Hbmass-responses is challenging, as adaptations can be concealed by measurement error. Using error-reducing duplicate measures of Hbmass, we aimed to identify individuals with an increase of Hbmass after 20 days of classical altitude training at 1800 m. **Methods** By a novel method combining two optimised CO-rebreathing procedures within hours (Naef et al., in press), Hbmass of seven male elite endurance athletes (all in the top eight of the Swiss national ranking in their disciplines) was assessed in duplicate before (T0) and after (T1) a three-week control period as well as after (T2) a subsequent 20-day classical altitude training period at 1800 m. **Results** Mean Hbmass at T0, T1 and T2 was  $936 \pm 38$ ,  $945 \pm 24$  and  $961 \pm 51$  g, respectively. The effect of the altitude stay on mean Hbmass was trivial in relation to the smallest worthwhile change of Hbmass (2%). Individual responsiveness was  $\pm 1.5\%$  from the mean effect. The 95% confidence limits for individual Hbmass changes ( $\pm 5.0\%$ ) were exceeded by two athletes. **Conclusion** We conclude that no mean increase of Hbmass can be expected after a three-week stay at 1800 m but that some individuals significantly increase their Hbmass nonetheless. Therefore, we recommend to elite athletes 1) to enhance the chance of an individual Hbmass benefit by completing their altitude training at > 1800 m and 2) to analyse their individual Hbmass-response to an altitude stay using duplicate measures pre and post altitude. **References** Friedmann, B., Frese, F., Menold, E., Kauper, F., Jost, J., & Bartsch, P. (2005). Individual variation in the erythropoietic response to altitude training in elite junior swimmers. *Br J Sports Med*, 39(3), 148-153. Naef, N., Steiner, T., & Wehrlin, J. P. (in press). Replicate measurements of haemoglobin mass during a single day are feasible and precise. *Int J Sports Med*. Pottgiesser, T., Ahlgrim, C., Ruthardt, S., Dickhuth, H. H., & Schumacher, Y. O. (2009). Hemoglobin mass after 21 days of conventional altitude training at 1816 m. *J Sci Med Sport*, 12(6), 673-675.

### DIFFERENCES IN TRUNK TWIST MOTION USING LONG OR HEAVY BATS WITH EQUAL MOMENTS OF INERTIA

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**Introduction** Increasing bat head velocity is an important way to improve hitting performance in baseball. Using a training bat with altered length or mass is one such method. These bats alter the moment of inertia (MOI). Previous studies have investigated training effects of using weighted bats (Sergo, 1993); however, none have investigated the characteristics in hitting motions using long bats or evaluated differences in hitting motions when players use bats with the equal MOI but different length and mass. This study aimed to investigate differences in hitting motions to focus on trunk twist, which is important in increasing bat head velocity (Fleisig et al., 2013), using training bats with equal MOI but different length and mass. **Methods** Eleven male collegiate baseball players participated in this study (age  $19.09 \pm 1.04$  years, height  $1.75 \pm 0.05$  m, mass  $72.45 \pm 8.12$  kg, mean  $\pm$  SD). All subjects performed tee batting with maximal effort. Four long bats (LB) and four weight bats (WB) were manufactured based on a normal bat (NB 0.84 m, 0.9 kg). LB and WB were manufactured to have the equal MOI (Spurr et al., 2014). The three-dimensional co-ordinates of nine reflective markers fixed on the body and bat were collected by the Vicon system (250 Hz). The swing motions was analysed from take-off of the stride leg to ball impact. The angular displacement of trunk twist and upper trunk and pelvic rotations were investigated in the transverse plane. **Results and Discussion** No significant differences in angular displacement of trunk twist and upper trunk and pelvic rotations were seen while using LB and WB. However, the angular displacement of trunk twist tended to be larger with increasing MOI using LB. Subjects were divided into two groups based on the mean value of angular displacement of trunk twist using NB: a large displacement group and a small displacement group. Participants in the small displacement group demonstrated larger differences in angular displacement of trunk twist using LB with the highest MOI when compared with NB. In the small displacement group, using NB, the pelvic and shoulder rotations started almost simultaneously. However, when the same subjects used LB with the highest MOI, pelvic rotation started before shoulder rotation. Thus, LB may contribute to improved trunk twist motion in players who cannot get a proper trunk twist with NB. **References** Sergo C, Boatwright D. (1993). *J Strength Cond Res*, 7(2), 115-117. Fleisig GS, Hsu WK, Fortenbaugh D, Cordover A, Press JM. (2013). *Sports Biomech*, 12(4), 324-333. Spurr J, Goodwill S, Kelley J, Haake S. (2014). *Procedia Engineering* 72, 569-574.

### THE SOMATOTYPE OF AFRICAN SPORTSMEN

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**Introduction** The knowledge of sportsmen somatotypes is of great importance for many researchers in sport and physical education (Malina, 1982; Wilmore, 1983; Heyters, 1986; Crankcase, 1990; Heyward, on 1999). During these last decades, several researchers were interested in the estimation of the composition and in the physical structure of sportsmen and proposed several equations. In front of this multitude of formulae estimating the same parameter, our choice concerned to determine the somatotype of our sample. The main of this study is the determination of the somatotypes of African sportsmen and to use the typology as parameter of control of the training plans. **Method** The study concerned athletes of the African national teams, who participated in the IXth African Games organized in Algiers. Anthropometric measures were taken during the African Games. We used an anthropometric suitcase of the type GPM (Siber Hegner firm) for all the measures. We determined the various somatotypes by using the software «Somatotype» conceived by Kagi Systems firm. **Results** The estimation of the somatotype gives an overview onto the physical composition and the structure of the high-level sportsmen. This overview can be used as parameter of control for training and allows rectifying errors of the planning. It thus seems

necessary to verify the good choice of a method of training from the variation between two main components: endomorphy and mesomorphy, to consider the level of preparation of an athlete. Conclusion Studies on somatotypes are still necessary to improve the evaluation of the physical composition. It is thus essential to determine our own anthropometric profiles of African somatotypes not to take any more in reference the data stemming from other populations. References CARTER JEL, Heath BH. (1990): Somatotyping. Development and applications. Cambridge: Cambridge University Press, . HEYTERS C. (1986) : Les dangers de la méthode des plis cutanés dans l'évaluation de la masse grasse du corps. *Cinésiologie (Paris)* 105, Janv/Fevr 1986, pp. 17-23 HEYWARD V.H. ; WAGNER D.R. (1999) : Techniques of body composition assessment : A review of laboratory and field methods. *Physical education, Recreation and dance* vol.70, n°2 : 135-149 MALINA R.M., MUELLER W.H., BOUCHARD C., SHOUP R.F., LA RIVIERE G. (1982) : Fatness and fat patterning among athletes at the Montreal Olympic WILMORE J..H. (1983) : Body composition in sport and exercise : Directions for future research. *Medicine and Science in Sports and Exercise* 15 (1) : 21-31 Indianapolis Key-words : somatotypes ; african ; sportsmen

## A METHODOLOGY FOR A TEAM PERFORMANCE SCORING SYSTEM FOR RUGBY UNION

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Introduction Studies of complex team sports, such as rugby union, that have assessed performance using a simple analysis of frequency data have struggled to identify a consistent statistically significant link between team performance indicators and match outcome (Vaz et al. 2011; Hughes et al., 2012). Methods This proof-of-concept study outlines a methodology that transforms standard notational analysis inputs into a qualitative assessment using a simple weighted algorithm for every action variable. From this, key highlights in individual matches can be automatically identified. Thirty nine home and away matches played by a single RFU National League 3 team in the 2011/12 season (n=26), and International matches played in 2011/2012 season (n=13) were coded and used to develop the system. Results Intra-operator reliability was tested on two matches from each population group, achieving an acceptable (<5%) difference across categories. The system was deemed to be valid as it correctly calculated 92% of National 3 and 82% of International match outcomes (excluding draws) and successfully identified key passages of play, for example 72.6% of tries at National 3 and 86.8% of tries at International level above the 80th percentile of key incidents despite try scoring events accounting for 17.62%  $\pm$  0.12% of system points awarded for National 3 games and 10.19%  $\pm$  0.10% of system points in International games. Discussion It is recommended that further research and development is required to improve the robustness of this system and the underlying academic assumptions. References Hughes, M., Hughes, M. D., Williams, J., James, N., Vuckovic, G., & Locke, D. (2012). Performance indicators in rugby union. *Journal of Human Sport and Exercise*, 7(2), 383–401. doi:10.4100/jhse.2012.72.05. Vaz, L., Mouchet, A., Carreras, D., & Morente, H. (2011). The importance of rugby game-related statistics to discriminate winners and losers at the elite level competitions in close and balanced games. *International Journal of Performance Analysis in Sport*, 11(3), 130–141.

## TRAINING INTENSITY DISTRIBUTION IN YOUNG TENNIS PLAYERS

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Introduction The aim of this study was to describe the distribution of training intensity in a group of elite young tennis players during both preseason and the beginning of their competitive season, based on the session rating of perceived exertion (session-RPE) and heart rate methods. Methods Twelve professional tennis players (age: 18.5  $\pm$  0.4 years; height: 178.0  $\pm$  4.0 cm; body mass: 72.4  $\pm$  6.0 kg) participated in this study. HR and session-RPE were collected in 407 tennis training sessions (including 23 simulated matches) and 17 official matches, during the first 7 weeks of the competitive season. From week 1 to week 5, no official or simulated matches were performed. During the last 2 weeks (week 6 and week 7), simulated and official matches took place. Training intensity distribution was quantified from heart rate using pre-defined HR and session RPE zones (HR: Zone 1 = <70%HRMAX; Zone 2 = >70-85% HRMAX; Zone 3 = > 85% HRMAX and session RPE: Zone 1 = <4; Zone 2 = >4-7; Zone 3 = > 7). Results All individual correlations between the session RPE method and the HR-based method were significant ( $r = 0.58 - 0.89$ ;  $p < 0.01$ ). The correlation coefficients between methods during on court tennis training sessions, simulated and official matches were  $r = 0.74$ ,  $r = 0.57$  and  $r = 0.99$ , respectively. The total training time spent in the heart rate zone 1 (52.00%) and zone 2 (37.10%) was greater than the time spent in zone 3 (10.90%) during the training period ( $p < 0.05$ ). Similarly, the total training time spent in the session RPE zone 1 (42.00%) and zone 2 (47.50%) was also greater than the time in zone 3 (10.50%) ( $p < 0.05$ ). Discussion The data of the present study demonstrated that these young tennis players train in a low to moderate intensity zone, and therefore under the intensity performed in the official matches. Additionally, the current data indicated that young tennis players adopt a polarized training intensity distribution. [email: aoki.ms@usp.br]

## AGREEMENT BETWEEN DIFFERENT APPROACHES OF A SLED TOWING SPRINT TEST

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Introduction A critical examination on key elements and fundamental features of training methods is crucial in order to achieve more consistent results. The execution of running tests with loads demands application of a proper rest interval, which will allow the achievement of maximal performance. Hence, this study aimed to analyze the agreement between a running protocol performed with different loads, with a determined rest interval, and a protocol in which the running tests with different loads were performed in different days. Methods Eleven athletes practicing sprint running participated in this study. One protocol included sprints of 50 m, in four distinct situations: without a sled; towing a sled with a load corresponding to 20% of body mass (including the sled weight); 30% and 40%. The order of the running tests was randomized and a rest interval of 15 min separated each test. After about two weeks, the athletes performed each running test, with each load, in separate days. Time was measured with an automatic timing system, including the watch and timing gates for start and finish (Freelap SA, Fleurier, Switzerland). Bland Altman testing was applied using the software Analyse-it 2.3, with a level of significance of 0.05. Results An agreement between protocols was found for running without sled and for sled towing with a load corresponding to 20% of body mass, showing a bias of 0.039 and -0.032, respectively, without significant difference. In contrast, for loads corresponding to 30% and 40% of body mass, an agreement was not assumed, because bias was greater and distant from zero (-0.303 and -0.496, respectively), with significant difference for 30% load. Discussion The lack of agreement observed for greater loads may be associated with the reduced time performed by the athletes during running in separate days. Probably, when running with 30% and 40%, in randomized order with tests involving 20% and without sled, with 15 min rest interval, athletes were under the effect of

fatigue, which possibly was not present during testing in separate days. This effect can be ascribed to a fatigue on stretch-shortening cycle (Komi, 2000) and/or due to intrinsic local/muscular mechanisms (e.g. myofibrillar  $Ca^{2+}$  sensitivity, Allen et al., 2007). This may have caused the difference in running time between protocols. In conclusion, for running without a sled or towing a sled with load of 20% of body mass, there is an agreement between tests performed separately and those performed at the same day, with 15 min rest interval, in contrast to what was observed for loads corresponding to 30% and 40% of body mass. References Allen D, Lamb G, Westerblad H. (2008). *Physiol Rev*, 88, 287-332. Komi P. (2000). *J Biomech*, 33, 1197-1206. Contact pattyant@hotmail.com

### RELATIONSHIP BETWEEN TOE TOUCH JUMP ABILITY AND PHYSICAL FACTORS IN CHEERLEADERS

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Jump is one of the important elements of competitive cheerleading. It is the only technique that everyone in the team performs at the same time. Toe touch jump with the leg straddled parallel to the frontal plane is the most common technique. The evaluating criteria of toe touch jump are not only the height of jump but also the degree of legs. Therefore, physical skills for performing toe touch jump can be many factors. Moreover, the skills and physical factors of toe touch jump remain nucleated, and there seems only few guideline of coaching. Therefore, the purpose of this study is to clarify relationship between toe touch jump ability and physical factors in cheerleader. Sixteen female cheerleaders participated in this study ( $158 \pm 5.8$  cm,  $53.5 \pm 5.6$  kg,  $19.5 \pm 1.37$  yrs). Body composition, vertical jump, repetition maximum of parallel squat and functional movement screen (Gray Cook 2010) were measured. As an indicator of the flexibility the passive leg angle (PROM) was measured when participants performed the maximum angle of leg holding by hand while standing on the other leg. The maximum and minimum angle of the leg (AROM) were measured after participants held leg for 6 seconds without hands while standing as an index of muscle strength. To evaluate the jump skill, we recorded toe touch jump in frontal and sagittal plane and calculated the leg angle of each participant's toe touch jump. Significant positive correlation between the leg angle of the toe touch jump and vertical jump ( $r=0.569$ ), maximum AROM of the left leg ( $r=0.597$ ), minimum AROM of the left leg ( $r=0.543$ ) were observed ( $p < 0.05$ ). There was no correlation between the toe touch jump performance and the other physical factors. To perform better toe touch jump, one has to have a better jump ability. Those who jump higher can have longer time in the air, therefore have time to perform large leg angle. While positive correlation between leg angle of toe touch jump and AROM was observed, PROM wasn't. Therefore, to develop the skills of toe touch jump, the jumping ability and muscle strength of the hip and trunk that enables one to bring legs up in the air are necessary.

### HEART RATE RESPONSES TO TRAINING AND TESTING IN POSTPUBESCENT FEMALE VOLLEYBALL PLAYERS: THE EFFECT OF MATURITY

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Introduction Although physiological characteristics have been well studied in female volleyball players (e.g. Nikolaidis et al., 2015a,b; Nikolaidis et al., 2014; Nikolaidis et al., 2012), less information about the physiological impact (e.g. heart rate, HR) of maximal and submaximal exercises either on field or laboratory is available. Moreover, the effect of maturity on this impact has not been studied so far. Therefore, the aim of the present study was to examine the effect of maturity, assessed as difference between chronological age and age at peak height velocity, on HR responses to maximal and submaximal laboratory and field exercises. Methods Twenty-eight postpubescent female volleyball players participated in the present study (age 13.8 (0.6) yrs, body mass 62.5 (8.2) kg and height 1.73 (0.05) m; mean (standard deviation)). They were divided into two groups with regards to their maturation: less matured (LM) and more matured (MM). In laboratory, HR was recorded during 5 min rest, physical working capacity in heart rate 170 bpm, 3 min step test, 30 s Bosco test and Wingate anaerobic test (WAnT) were performed. In field, a 70 min training session (consisted by three parts: warm-up, 1x1 drills and team drills) was monitored and 20 m shuttle run endurance test was performed. Results There was significant difference between LM and MM groups over HR responses (%HR reserve, %HRR) to exercise training ( $F(2,21)=6.08$ ,  $p=0.008$ ,  $\eta^2=0.37$ ). There was a main effect of part session of exercise program on HR responses with the highest intensity recorded in 1x1 drills (~75%HRR) and the lowest in team drills (~60%HRR in LM and ~65%HRR in MM). There was also a moderate effect of maturity on HR during cycling against 90 W and in the WAnT, and small effect on HR during cycling against 60 W, in the end of the step test, Bosco test and running endurance test, where the highest scores were recorded in LM. Conclusions Based on the findings of the present study, it was concluded that maturity exerted an effect of small to moderate magnitude on HR responses in a laboratory setting and this should be taken into account by coaches and trainers when evaluating physiological characteristics. References Nikolaidis PT, Afonso J, Busko K, Ingebrigtsen J, Chtourou H, Martin JJ (2015a). *Kinesiol*, 47(1). Nikolaidis PT, Afonso J, Busko K (2015b). *Sport Sci Health*, epub. Nikolaidis PT, Padulo J, Chtourou H, Torres-Luque G, Afonso J, Heller J (2014). *Hum Mov*, 15(3):166-170. Nikolaidis PT, Ziv G, Arnon M, Lidor R (2012). *J Strength Cond Res*, 26(9):2547-57. Contact pademil@hotmail.com

### ACUTE EFFECTS OF LOW-INTENSITY RESISTANCE TRAINING WITH SLOW MOVEMENT IN SWIMMING: A PILOT STUDY

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Introduction Low-intensity resistance training with slow movement and tonic force generation (LST) has been recently proposed as effective for strength improvement (Tanimoto et al., 2009). Transferability of the effects of dry-land strength training on swimming performance is still debated and questioned (Aspenes et al., 2012). Nevertheless, this pilot study aimed to assess whether LST and slow strip set resistance training (SSS) might affect front crawl swimming, while specific in-water adaptations were not performed. Methods Eight male swimmers were randomly assigned to LST or SSS dry-land resistance training. Participants trained for 6 weeks, 3 times per week, by one set until to complete exhaustion of: i) LST: push-ups, 5s down + 5s up; ii) SSS: knee push-ups, 5s down + 5s up, further decreasing the load by changing the angle at the knee (120-90-60 degrees) just before exhaustion, at each angle. During the training, participants were asked to reduce their swimming sessions. The muscular strength of the upper limbs (nr. of push-ups in 30s, PU30) and the velocity in the central 10m ( $v_{10}$ ), the stroke rate (SR), the stroke length (SL) and the Efficiency Index ( $EI = v_{10} * SL$ ) during a 25m all-out front crawl bout were measured, before and after training. Mixed two-way ANOVA was applied to assess differences between pre- and post-training, and between groups. Results Pre- and post-training significantly differed, while no intercepts were found between LST and SSS, in each parameter. PU30 and SR increased by 5% ( $p=0.022$ ) and 4% ( $p=0.049$ ),  $v_{10}$  and EI decreased by 5% ( $p=0.011$ ) and 6% ( $p=0.043$ ), respective-

ly. Discussion Six weeks of dry-land LST and SSS are confirmed to equally improve the muscular strength of the upper limbs (Alberti et al., 2013). However, the swimming performance did not reflect improvement in muscular strength, which has been obtained by dry-land strength training. The significant decline of swimming performance and stroke parameters might be due to troubles in the readjustment of the motor patterns, consequently to changes induced by muscular strength gain (Aspenes et al., 2012). SR and EI variations would confirm this assumption. Furthermore, LST and SSS would not be satisfactorily specific for and transferable to swimming performance. Altogether, the contribution of LST and SSS to training for swimmers should be fully clarified, also in association with in-water specific practice. References Alberti G, Cavaggioni L, Silvaggi N, Caumo A, Garufi M. (2013). *Strength Cond J*, 35(1), 42-47. Aspenes S, Karlsen T. (2012). *Sports Med*, 42(6), 527-543. Tanimoto M, Kawano H, Gando Y, Sanada K, Yamamoto K, Ishii N, Tabata I, Miyachi M. (2009). *Clin Physiol Funct Imaging*, 29(2), 128-135. Contact raffaele.scurati@unimi.it

## THE DIFFERENTIAL LEARNING APPROACH IN STRENGTH TRAINING

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Introduction The methods of classical strength training have not changed a lot in the past few years. The training recommendations in Europe and in the US are very similar and still mainly rely on Zatsiorsky (1972) and Kusnezow (1975). In all methods deviations from prescribed exercises (fluctuations) are completely neglected. Fluctuations are exploited in the differential learning (DL) approach, which shows positive effects for motor learning in sports and physical therapy (Schöllhorn, Beckmann, Davids, 2010). The aim of this study is to investigate whether the DL approach is practicable in strength training (Squat). Methods 24 healthy and physically active men ( $25.5 \pm 2.5$  years) were tested for their one repetition maximum (1RM) in the squat and in the performance of Countermovement Jump (CMJ), Squat Jump (SJ) and Drop Jump (DJ) before and after two types of training interventions with two training sessions per week. A classical training group (CG) trained with a weight of 60 to 97.5% of the 1RM according to the principles of hypertrophy, strength and power and the realizable repetitions. A DL group (DG) trained with only approximately 60% of the 1RM with an overall identical load in comparison to the CG. In difference to the DG the fluctuations of movement executions were held up as much as possible between every repetition and every set. Results For the 1RM in the squat the within-subjects effect time is highly significant and the observed effect size is very high (F1, 22 = 128.0,  $p = .000$ ;  $\eta^2 = .853$ ). For the within-subjects effect of interaction time and group (F1, 22 = .672;  $p = .421$ ;  $\eta^2 = .03$ ) as well as for the between-subject effect group (F1, 22 = .088,  $p = .769$ ;  $\eta^2 = .004$ ) the results are not significant. Significant results can be observed for all three jump-tests with respect to the factor time with a high effect size (CMJ: F1, 22 = 59.037,  $p = .000$ ;  $\eta^2 = .729$ ; SJ: F1, 22 = 48.850,  $p = .689$ ;  $\eta^2 = .689$ ; DJ: F1, 22 = 52.825,  $p = .000$ ;  $\eta^2 = .706$ ). A significant result with a medium effect size for interaction of time and group can only be detected at the CMJ (F1, 22 = 5.308,  $p = .031$ ;  $\eta^2 = .194$ ). All other results are not significantly. Discussion Both groups can noticeably increase their performance in the 1RM. It is remarkable that the DG can realize this increase with a lower intensity of training load. Both groups enhance their jumping heights in the post-test. Only in the CMJ a greater improvement of the CG is observed. The results encourage for further research towards more variations in strength training. References Schöllhorn WI, Beckmann H & Davids K (2010). *Medicina*, 46(6), 365-73. Kusnezow V (1975). *Kraftvorbereitung*. Sportverlag, Berlin. Zatsiorsky VM (1972). *Die Körperlichen Eigenschaften des Sportlers*. Bartels & Wernitz, Berlin. Contact hegenp@uni-mainz.de

## DEVELOPMENT OF AEROBIC WORK CAPACITIES ON YO-YO INTERMITTENT RECOVERY TESTS IN AGED FROM 13 TO 22 YEARS OLD JAPANESE MALE SOCCER PLAYERS.

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Purpose The purpose of this study was to clarify development of aerobic work capacities on Yo-Yo intermittent recovery test in Japanese male soccer players. Methods This study was participated in 185 male soccer players aged from 13 to 22 years old. Subjects were classified into 8 chronological age group (12G, 13G, 14G, 15G, 16G, 17G, 18G, 19G and 20G). Subjects were performed Yo-Yo intermittent recovery test level 1 (Yo-Yo IR1) and level 2 (Yo-Yo IR2) (Bangsbo, J. and Mohr, M., 2012). Comparison of age group difference was analyzed by one-way ANOVA with Bonferroni-Dunn multiple comparisons post hoc test. Regression analysis was used double logarithmic graph in relationship between body height and Yo-Yo IR1 and Yo-Yo IR2. Intermittent work capacity index (IWCI: YoYo IR2 / YoYo IR1) was calculated in all the subjects. Results Running distance of Yo-Yo IR1 was obtained significantly difference between 14G ( $845.0 \pm 373.8$ m) and 15G ( $1556.7 \pm 409.7$ m), 17G ( $1666.7 \pm 402.6$ m) and 19G ( $2902.5 \pm 473.5$ m). And also, running distance of Yo-Yo IR2 was obtained significantly differences between 14G ( $192.5 \pm 51.2$ m) and 15G ( $435.6 \pm 167.3$ m), 17G ( $417.8 \pm 165.9$ m) and 19G ( $1320.0 \pm 350.1$ m). CV of Yo-Yo IR1 distance were decreased due to chronological age. However, CV of Yo-Yo IR2 distance was not changed among the all age groups. Yo-Yo IR1 was significantly correlated to the Yo-Yo IR2 in all the subjects ( $r=0.902$ ,  $p<0.05$ ). In the relationship between body height and Yo-Yo IR1 and Yo-Yo IR2, running distances were increased at the 167.0 and 166.3 cm, respectively. There were significantly increased from 17G to 19G in IWCI. Discussion Yo-Yo IR1 and Yo-Yo IR2 were developed from 14 to 15 years old in male soccer players. Running distance of Yo-Yo IR1 and Yo-Yo IR2 were increased at the about 167 cm. Therefore, Physical growth was effected on aerobic work capacity. But also, Rate of high intensity intermittent performance (Yo-Yo IR2) were improved during post adolescence. From these findings, it seems that using Yo-Yo intermittent recovery test must be considered for physical growth in male adolescent soccer players. References Bangsbo, J., Mohr, M. (2012), *Fitness testing in football*. Contact teshima@kokushikan.ac.jp

## THE AGREEMENT BETWEEN LACTATE MINIMUM POWER AND 3 MINUTE ALL-OUT CRITICAL POWER

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Sport scientists have long sought a test which accurately predicts maximal lactate steady state (MLSS). Whether the 3 min all-out test for determining critical power (3minCP) meets this brief remains contentious [1,2]. The aim of this study was to test the agreement between 3minCP and lactate minimum power which has previously been shown to provide an excellent estimate of MLSS [2]. Nine recreationally active males of diverse training status (age: 27 (10) years; body mass: 78 (11) kg; height: 181 (7) cm) initially performed a validated lactate minimum cycling test [2] comprising three consecutive phases: (I) lactate elevation phase comprising maximal, incremental exercise ( $30W \cdot \text{min}^{-1}$  ramp); (II) 8 min recovery phase at 60 watts (W); and (III) an incremental phase comprising five consecutive 4 min stages at 45, 50, 55, 60 and 65% of peak power achieved during phase (I). Lactate minimum power was defined as the nadir of a 2nd order polynomial function (identified by differentiation) fitting the blood lactate concentration (measured at the end of each stage) vs. power data.

Participants completed two 3 min all-out tests. The first test served as familiarization and data were not included in subsequent analyses. The 3 min all-out test resistance was set using the linear mode of the Lode Excalibur Sport cycle ergometer to allow the attainment of a power output halfway between peak oxygen uptake and the gas exchange threshold (determined during phase I of the lactate minimum test) on reaching the preferred cadence (linear factor = power/ cadence<sup>2</sup>). Feedback of elapsed time was not provided to prevent pacing, however participants were given strong verbal encouragement throughout and were instructed to maintain their highest possible cadence throughout the 3 minutes. The 3minCP was defined as the average power achieved during the final 30 seconds of the test. All tests were separated by at least 48 h. Lactate minimum power (182 [55]W, min: 99W, max: 259W) was lower ( $p < 0.05$ ) than 3minCP (253 [80]W, min: 145W, max: 374W). The difference between lactate minimum power and 3minCP correlated positively ( $p < 0.05$ ) with lactate minimum power. Several participants tolerated the 3minCP test poorly, reporting symptoms of nausea and lightheadedness after completing the test. These findings agree closely with a previous report [3] that 3minCP overestimates MLSS by around 50-80W with agreement becoming worse at higher powers. These findings suggest that the lactate minimum test is better tolerated and provides a much closer estimate of MLSS within a single laboratory visit. [1] Burnley et al (2006) *Med Sci Sports Exerc* 38: 1995-2003 [2] Johnson et al (2009) *Int J Sports Med* 30: 448-454 [3] Sperlich et al (2011) *Int J Sports Med* 32: 433-437

### COMPUTERIZED DEVICE FOR TESTING AND TRAINING OF SHOULDER GIRDLE MUSCLES FOR FITNESS AND REHABILITATION CENTERS

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Fitness training includes programs for both aerobic and strength training adapted to subject's current functional capacities. Development of shoulder girdle contractile characteristics is important: 1) for increasing aerobic capacities of elite athletes in skiing, swimming etc., 2) for fitness training as arm muscles are usually less trained than leg muscles; 3) in rehabilitation as working of arm muscles induces greater shifts in cardio-vascular and respiratory systems than leg muscles; 4) for patients with damaged mobility of lower extremities because usage of training machines for arms is the only accessible method of training for them. The aim of our study was to design a "training and gauge" device for aerobic and strength training and testing of arm muscles for fitness and rehab centers. The device is to set profile of load changes, follow the reproduction of load by subject and physiological changes in his organism. The device consists of power block, controller, external sensors and tablet computer with specialized software. The load in power block originates from braking of rotating metal fly wheel in the magnetic field. The resistance force depends on rotation speed, therefore the load is close to isokinetic. The software allows to measure the parameters of load and provides user interface for different regimes of training and testing. The user may design testing protocol, save it in graphical form. During training the previous training protocol will be loaded, the user may edit it, or choose the protocol suggested by software according to the results of last testing. Usage of tablet computer permits to monitor current values of load parameters and physiological indices in graphical form, therefore to control load and physiological state of the subject during training or testing. Data base allows to keep training diary. Various external sensors for measuring heart rate, muscle force, angles and angular velocities, EMG, tissue oxygenation etc. may be plugged in. It is of special importance in functional diagnostics. The work was supported by the Ministry of Education and Science of Russian Federation (subvention No 14.604.21.0029)

### PRIOR UPPER BODY RESISTANCE EXERCISE IMPAIRS SUBSEQUENT INTERMITTENT RUNNING PERFORMANCE

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Concurrent resistance and endurance training using the same muscle groups is often prescribed to improve sports performance and physical fitness. However, prior resistance exercise may limit the ability to perform subsequent endurance exercise training if insufficient recovery is provided [1]. Although this may, in part, be attributed to the same muscle groups being engaged in the strength and endurance exercise training, it is also possible that endurance exercise tolerance (e.g. running) is limited by prior resistance exercise using different muscle groups (e.g. upper body) due to an increase in the perception of effort. This study thus examined the effects of prior upper body resistance exercise on subsequent intermittent running performance. Ten male 1st team university rugby players (age: 22 (1) years; body mass: 87 (9) kg; height: 181 (5) cm) performed 1RM assessment for four upper body resistance exercises: bench press, seated row, seated military press, and seated latissimus dorsi pull-down. Thereafter, participants performed 2 Yo-Yo intermittent recovery level 1 tests (YYIR1) separated by 1 wk. Tests were randomised and performed with (UB-RUN) or without (RUN) prior upper body resistance exercise. Prior resistance exercise comprised 5 sets of 12 repetitions at 60% 1RM for each of the four exercises described above. Sets and exercises were separated by 1 min rest intervals. Resistance exercise was followed by 6 min rest before the start of the YYIR1. Heart rate (HR), capillary blood lactate concentration ([La]B), and rating of perceived exertion (RPE) were measured at rest, after upper body resistance exercise (UB-RUN) or an equivalent period of rest (RUN), and upon completion of the YYIR1. Running distance during the YYIR1 was 37% lower in UB-RUN (812 (300) m) compared with RUN (1286 (282) m) ( $P < 0.01$ ). After upper body exercise (UB-RUN) or an equivalent period of rest (RUN) [La]B (UB-RUN vs. RUN: 13.2 (3.1) vs. 1.3 (0.2) mmol/L), HR (147 (14) vs. 64 (8) bpm) and RPE (18.1 (0.9) vs. 6.0 (0.0)) were higher in UB-RUN compared with RUN ( $P < 0.01$ ). Upon completion of the YYIR1 [La]B (15.1 (3.6) vs. 10.5 (2.2) mmol/L) and RPE (19.9 (0.3) vs. 18.8 (1.0)) were higher ( $P < 0.01$ ), whereas HR was lower (178 (9) vs. 188 (7) bpm) ( $P < 0.05$ ), in UB-RUN compared with RUN. In summary, prior upper body resistance exercise impaired subsequent intermittent running exercise performance. The reduced ability to perform endurance exercise due to prior resistance exercise is thus not dependent on the same primary muscle groups being used in both training modalities and may be related to an accelerated increase in the perception of effort. These findings may have implications for the design and efficacy of concurrent resistance and endurance training programmes. [1] Robineau et al. *J Strength Cond Res*. In Press

### SUBJECTIVE COACH ASSESSMENT OF BIOLOGICAL MATURATION IN ELITE YOUTH SOCCER

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Introduction Biological maturation (BM) of young athletes is implicit in models of talent identification, selection, and development. In several elite team sports proportionally more players were detected who are advanced (early) in BM and proportionally fewer players who are delayed (late) in BM (Malina, et al. 2012). The aims of the present study were twofold: firstly, to assess the biological maturation of elite under-15 (U-15) soccer players and secondly, to determine if coaches are able to classify BM of soccer players compared to a categorization by X-ray. Method Subjects: 119 male Swiss soccer players (age: 14.0±0.3 years; weight: 53.0±8.7 kg; height: 164.9±8.4 cm) of the U-

15 national team. Measurements: X-rays of the left wrist-hand were performed to evaluate BM. Bone age assessment was calculated blinded by a trained observer according to the reference method of Tanner & Whitehouse (1975). Players were classified as late, on time (normal) or early maturing on the basis of the difference between skeletal age (SA) and chronological age (CA). On time was defined as an SA within 1.0 year of CA. Early maturing was defined as an SA in advance of CA by more than 1.0 year. Late maturing was defined as an SA younger than CA by more than 1.0 year. Additionally three coaches observed the players during a training session and did a visual subjective assessment applying the same maturity categories (late, normal, early developed). Statistics: Cohen unweighted kappa coefficients were calculated to evaluate the concordance of maturity classifications using IBM SPSS. The level of significance was set at  $p < 0.05$ . Results The players had a mean SA of  $13.9 \pm 1.1$  years (range: 11.7 – 16.4) measured by X-ray. In comparison to chronological age players were advanced by  $0.1 \pm 1.1$ . 25 players were rated as late developed, 70 players as normal developed and 24 players as early developed. The visual subjective assessments of coaches showed moderate agreement ( $k = 0.48$ ) with the x-ray profiles. Assessments were identical in 88 of the 119 (74%) occasions. Discussion In contrast to previous research Swiss elite U-15 soccer players were not accelerated in SA (Malina, et al. 2012). The coaches of elite youth teams were able to demonstrate a good “feel” for assessing BM compared to the classifications using X-ray. Therefore subjective assessment of BM might be a useful and practicable tool in talent identification of youth soccer players. In the same manner subjective assessment of BM might be helpful for the purpose of designing training programs. References Malina, R. M., Silva, M. J. C. E., Figueiredo, A. J., Carling, C., & Beunen, G. P. (2012). Interrelationships among invasive and non-invasive indicators of biological maturation in adolescent male soccer players. Tanner, J. M., Whitehouse, R., Cameron, N., Marshall, W., Healy, M., & Goldstein, H. (1975). Assessment of skeletal maturity and prediction of adult height (TW2). Academic Press London.

## THE ASSOCIATION BETWEEN MUSCLE POWER, AEROBIC CAPACITY AND SWIM TIME PERFORMANCE IN YOUNG, COMPETITIVE SWIMMERS

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Introduction Swim time performance is affected by physiological factors such as muscle strength and power of the upper and lower extremities as well as aerobic capacity (Smith et al., 2002). The association between these factors and swim time performance may plausibly identify some of the determinants for performance enhancement in swimming (Smith et al., 2002). In order to detail the individual training programme, reference values are needed. The aims of this study were firstly to determine the association between muscle strength and power, aerobic capacity and 100 m freestyle time (FT) in young, competitive swimmers, and secondly to determine reference values for these physiological factors. Methods In total, 119 competitive swimmers aged 11-15 years were assessed with Grip Strength (GS), Vertical Jump (VJ) and an intermittent running test to estimate maximal oxygen uptake, the Andersen Test (AT). Swim time performance, expressed as 100m FT, was obtained from a national database for Danish swimmers. A multiple linear regression model was used to determine the association between GS, VJ, AT and 100m FT, adjusted by sex, age, height and weight. Results A negative association was found between GS ( $p = 0.002$ ), VJ ( $p = 0.01$ ) and 100 m FT for both boys and girls, seen as an increase of one kg in GS improving the swim time by 0.3 sec and similarly, an increase of one cm in VJ improving the 100 m FT by 0.3 sec. For the AT, a negative association with 100 m FT ( $p = 0.001$ ) was also found, indicating that an increase in running distance by 10 m increased the swim time performance with 0.3 sec. An increase of 3.6 sec in swim time performance was seen with increasing age ( $p = 0.001$ ). Reference values differed between sex and ages, with boys performing better than girls in all tests, and with increasing values by increasing age. Conclusion Muscle strength and power tests for upper and lower extremities, expressed as GS and VJ, were found to be significantly and negatively associated with 100 m FT in the current study. Also, increasing aerobic capacity was found to improve swim time performance. These simple and low-cost tests, including data on reference values for each test, may be considered in order to improve dry-land training prescription, thereby supporting the enhancing swimming performance in young, competitive swimmers. References (1) Smith, J.D., Norris, S.R., Hogg, J.M. Performance Evaluation of Swimmers - Scientific Tools. Sports Med 2002; 32 (9): 539-554 Contact Email: pehe@ucl.dk

## THE ANALYSIS OF GLENO-HUMERAL RHYTHM AFTER REPETITIVE THROWING BY 3D DIGITIZER

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Introduction Fatigue associated with repetitive throwing can lead to scapular malposition among pitchers and overhead athletes (Pellegrini A, et al., 2013). In case of measuring the position of scapular, 3D electromagnetic tracking system is available in previous studies. However, this apparatus has some limitations that it can only apply under free metal environment (Rosa DP, et al., 2013) and analyze less than 120° of humeral elevation (Karduna AR, et al., 2001). Meanwhile, 3D digitizer is a useful device in terms of measuring three dimensional coordinate accurately in a short period (Boldt F, et al., 2009; Keibaetse M, et al., 1999). The aim of this study was to analyze gleno-humeral rhythm after repetitive throwing by 3D digitizer. Methods Six healthy males (age:  $21 \pm 0.89$  years old, height:  $174.03 \pm 9.23$  cm, weight:  $65.68 \pm 9.67$  kg) were participated in this study. We measured their bilateral scapular position at 0°, 30°, 60°, 90°, 120°, 150° of humeral elevation before 60 repetitive throwing and five consecutive days starting on the day of throwing by 3D digitizer (Microscribe® G2X, Revware Inc., USA and Rhinoceros ver.5.0, Robert McNeel & Associates, USA). Dominant side of scapular position including (1) Upward - Downward rotation, (2) Internal - External rotation, (3) Anterior - Posterior tilting, (4) Flexion - Extension, (5) Elevation - Depression were compared with non - dominant side at each humeral elevation. Results In our pilot study, reliability of 3D digitizer showed that ICC(2.1), 95%CI, and SEM were 0.8~0.74, 0.96~0.51, and 0.47~0.13 [mm], respectively. Dominant side of scapular position has been significantly changed downward rotation ( $\Delta 10.84 \pm 3.45^\circ$ ) at 120° of humeral elevation and also extension ( $\Delta 7.23 \pm 2.35^\circ$ ) at 60° of humeral elevation after 1 day, exclusively ( $p < 0.05$ ). Discussion Previous study showed that less posterior tilting (up to 90° of elevation), external rotation (up to 120° of elevation), and upward rotation (up to 60° of elevation) were observed significantly in the early to middle phases of humeral elevation with shoulder muscle fatigue (Tsai NT, et al., 2003). Our results indicated that less upward rotation of scapular was also occurred at 120° of humeral elevation after repetitive throwing. Thickness of subcutaneous tissue would be influenced when the scapular position was calculated by 3D digitizer. This work has been supported by JSPS KAKENHI Scientific Research (C) Number 25350775. References Pellegrini A, Tonino P. (2013). Musculoskelet Surg, 97 (Suppl 1), S9-S13. Rosa DP, Albuquerque-Sendin F. (2013). J Manipulative Physiol Ther, 36, 546-554. Karduna AR. (2001). J Biomech Eng, 123(2), 184-90. Boldt F, Weinzierl C. (2009). J Orofac Orthop, 70, 247-263. Maikutlo Keibaetse, Philip McClure. (1999). Arch Phys Med Rehabil, 80, 945-950. Tsai NT, Phil W. (2003). Arch Phys Med Rehabil, 84, 1000-1005. Contact Dr. Takahiro Otsudo, PT, PhD [otsudo@saitama-med.ac.jp]



## INFLUENCE OF A NEW RE-BREATHING DEVICE ON PHYSIOLOGICAL STRAIN DURING MODERATE EXERCISE IN FIRE-FIGHTERS AND TRAINED SUBJECTS

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Introduction Life and health of firefighters during action is substantially dependent on a proper oxygen supply and they are required to use a self-contained breathing apparatus for respiratory protection when engaged in a variety of firefighting duties. The device provides crucial respiratory support and protection (Coca et al. 2011). Even at moderate physical demands rate of air consumption in these tasks will deplete the air supply within a short period of time (Williams-Bell et al. 2010) and re-breathing devices may extend the duration. The aim of this study was therefore to evaluate the influence of a new re-breathing device on physiological strain during moderate exercise. Method 22 male trained subjects and firefighters ( $29.0 \pm 9.2$  yrs,  $72.4 \pm 8.6$  kg) performed a standard incremental cycle ergometer exercise to determine the first (LTP1) and the second (LTP2) lactate turn point for subsequent exercise prescription. Some days later subjects performed three blocks (10 min) of constant load exercise at mid-point between LTP1 and LTP2 interspersed by 9 min of passive recovery in a randomized order in warm-up (WU), breathing ambient air (A) or re-breathing (RB) every second breath of exhaled air through a CO<sub>2</sub> filter applying a mechanic valve system. Heart rate (HR) was measured continuously and blood lactate concentration (La) was measured at the start of exercise and every min throughout exercise. Gas exchange data were measured applying two systems for inhaled and exhaled air. Results Power output at LTP1, LTP2 and Pmax were  $97.1 \pm 25.1$  W,  $208.7 \pm 35.1$  W and  $300.2 \pm 45.5$  W, respectively. Oxygen content in RB was 18.2% equivalent to 1100 m altitude. HR (A:  $142.8 \pm 10.6$  b.min<sup>-1</sup>; RB:  $144.5 \pm 11.3$  b.min<sup>-1</sup>) during moderate exercise was significant different between A and RB but not for La (A:  $1.89 \pm 0.76$  mmol.l<sup>-1</sup>;  $1.95 \pm 0.78$  mmol.l<sup>-1</sup>) although these differences are not physiologically relevant. Conclusion Re-breathing exhaled air with reduced oxygen content does not increase physiological strain at moderate task specific exercise intensity in firefighters under laboratory conditions. However, real situation simulations are needed to evaluate the system while wearing full protective gear and the breathing device. References Coca A, et al.: Field evaluation of a new prototype self-contained breathing apparatus. *Ergonomics*. 2011 Dec;54(12):1197-206. doi: 10.1080/00140139.2011.622797. Williams-Bell FM, et al.: Physiological responses and air consumption during simulated firefighting tasks in a subway system. *Appl Physiol Nutr Metab*. 2010 Oct;35(5):671-8.

## ACUTE EFFECT OF A CROSSFIT WORKOUT ON PATELLA, ACHILLES AND PLANTARIS TENDON THICKNESS

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Introduction CrossFit is a strength and conditioning program built around constantly varied functional movements performed at high intensity in order to create a well-rounded athlete. Tendons are highly adaptive to load change, however little is known about their acute response to the strenuous and explosive physical exercise involved in CrossFit. The aim of this study was to investigate the immediate effect of a lower extremity CrossFit workout on patella, achilles, and plantaris tendon thickness. Methods A convenience sample of 34 healthy adults (26.5% females), who were regularly active in CrossFit, participated in this study. Female participants had a mean age of 28 (SD 10) years; weight 61 (6) kg; and height 166 (7) cm. Male participants had a mean age of 28 (SD 8) years; weight 79 (11) kg; and height 181 (7) cm. Sonograms (Hitachi Nobulus, 18 mHz probe) of the patella, achilles, and plantaris tendons were acquired perpendicular to the point of maximum tendon width according standardized settings and acquisition protocol. When, tendon thickness was measured at the thickest point of the tendons, the distance from the nearest bony point was also identified to be sure that the pre- and post-exercise sonograms were acquired at exactly the same point of the tendon. Following pre-exercise sonograms, participants completed a lower extremity CrossFit workout consisting of five rounds of 5 weighted back squats 50/30 kg; 10 box jumps (jumping onto and down from a 60/50 inch box), and 15 double unders (two rotations of a jump rope per jump). Sonograms were repeated immediately following completion of the CrossFit exercises. Results Paired-samples t-tests were conducted to compare tendon thickness before and after the CrossFit workout. Significant differences were observed in patella tendon thickness before ( $M=4.5$ ,  $SD=0.6$ ) and after ( $M=5.0$ ,  $SD=0.7$ ) workout,  $p<0.0001$ ; and in achilles tendon thickness before ( $M=4.4$ ,  $SD=0.4$ ) and after ( $M=4.5$ ,  $SD=0.5$ ) workout,  $p=0.01$ . There was not a significant difference in plantaris thickness before ( $M=3.4$ ,  $SD=0.5$ ) and after ( $M=3.4$ ,  $SD=0.5$ ) workout,  $p=0.97$ . Discussion These results suggest that a lower extremity CrossFit workout has an immediate impact on tendon thickness. Specifically, our results suggest that the thickness of the patella and achilles tendons increases after strenuous and explosive physical exercise of the lower extremities. This study adds to our understanding of the acute response of the patella, achilles, and plantaris tendons to high intensity lower body exercise. \*Contact filip-fisker@hotmail.com

## EFFECTS OF TWO DIFFERENT LOAD CARRIAGE EXERCISES ON PHYSIOLOGICAL RESPONSES IN SOLDIERS

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Introduction Load carriage ability is one of the most important physical capabilities for an infantry soldier. Modern soldiers are often well-equipped while the weight of load carriage depends on specific occupational tasks. Therefore, it is important to study the physiological responses induced by load carriage. The purpose was to examine metabolic changes in soldiers during a simulated road march with two different loads (29 kg and 45 kg). Methods Eight male soldiers participated in the study (age  $20 \pm 1$  yrs., height  $1.80 \pm 0.10$  m, body mass  $77.9 \pm 12.3$  kg, BMI  $23.9 \pm 2.4$ ,  $VO_{2max}$   $51.8 \pm 4.2$  ml·kg<sup>-1</sup>·min<sup>-1</sup>). Maximal oxygen consumption was determined one week before the first load carriage test, while maximal strength, muscular endurance and body composition a day before the first load carriage test. Between the two tests there were 48 h rest period. The load carriage tests were conducted on a treadmill. The first 45-min of the test was performed at the speed of 4 km·h<sup>-1</sup> and inclination of 1.0 deg. Thereafter, the angle and speed was increased by having their highest values of 12 deg and 6 km·h<sup>-1</sup>. Oxygen consumption ( $VO_2$ ), ventilation (VE), heart rate (HR), rating of perceived exertion (RPE) and blood lactate (La) were measured during the trials. Results Submaximal VE and HR were higher with the heavier load compared to the lighter load ( $p<0.05$ ). Time to exhaustion correlated with absolute maximum  $VO_2$  (ml·min<sup>-1</sup>), (29kg:  $r=0.80$   $p\leq 0.05$ , 45kg:  $r=0.92$   $p\leq 0.05$ ) but not with relative maximum  $VO_2$  (ml·kg<sup>-1</sup>·min<sup>-1</sup>). Maximal bench press results also correlated with both of the loads (29kg:  $r=0.75$   $p\leq 0.05$ , 45kg  $r=0.81$   $p\leq 0.05$ ). Maximal  $VO_2$  and maximal bench press were the only two factors from the pre-load carriage physical fitness tests that were associated with time to exhaustion in the two load carriage tests. Body weight and fat free mass correlated positively only with the heavier load ( $r=0.72$   $p\leq 0.05$ ), ( $r=0.74$   $p\leq 0.05$ ) and standing long jump with the lighter load ( $r=0.80$ ,  $p\leq 0.05$ ). A regression analysis revealed that height and bench press explained the variance of the load carriage test performance by 79% ( $p<0.01$ ). Discussion The

results of this investigation may indicate that upper body strength is a vital characteristic for carrying heavy loads. In addition, maximal aerobic capacity is important while operating near maximal effort with an additional load. Moreover, the load carriage performance of heavier soldiers may not be as hampered as that of lighter soldiers. The present results may suggest that strength training, especially for the upper body, and endurance training are beneficial for soldiers in order for them to sustain carrying of heavy loads. Contact [anttu.terho@mil.fi](mailto:anttu.terho@mil.fi)

### DIFFERENCES IN HEART RATE AT FIRST AND SECOND LACTATE TURN POINT IN TREADMILL RUNNING AND ERGOMETER CYCLING IN MAN

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**Introduction:** Based on a three-phase two turn point model, heart rate (HR) at the first (LTP1) and second lactate turn points (LTP2) represent reference markers for exercise prescription (Hofmann & Tschakert 2011). Very often HR recommendations from one type of ergometry are applied to various kinds of exercises (Röcker et al., 2003). Recently, we found a distinct difference and a highly individual variation in HR comparing running and cycling in woman (Wallner et al., 2014). The aim of this study was to analyse the HR at LTP1 and LTP2 in treadmill running and ergometer cycling tests in man. **Method:** 15 male students (21.1±2.0 years, 77.9±13.3 kg) performed two incremental tests within one week in randomized order. One test was performed as a running test (RT) on the treadmill and the other one as cycling test (CT) on a cycle ergometer. After 3 minutes of warm up at 2.0 m/s (RT) and 40 Watt (CT) workloads were increased every minute by 0.2 m/s (RT) and 20 Watt (CR), respectively to attain maximal power output within the same time frame. HR was measured continuously and blood lactate concentration (La) was measured at rest and after every load step. LTP1 and LTP2 were determined in both tests according to Hofmann & Tschakert (2011). **Results:** Mean workloads at LTP1, LTP2 and at termination of the test (MAX) were 2.65±0.20 m/s (60.8±4.0% vMAX), 3.35±0.38 m/s (78.9±2.8% vMAX) and 4.26±0.55 m/s in RT and 109.2±18.1 W (39.9±4.4% PMAX), 194.9±30.6 W (71.0±3.3% PMAX) and 273.3±32.7 W in CT, respectively. La at LTP1 (2.13±0.07 mmol/l vs. 1.37±0.32 mmol/l) was sig. higher in RT (p<0.01), but not at LTP2 (4.31±1.28 mmol/l vs. 3.98±0.82 mmol/l) and MAX (11.19±3.39 mmol/l vs. 10.93±2.52 mmol/l). HR in RT was significantly higher at LTP1, LTP2 and MAX (p<0.01) with a decreasing mean difference (169.4±9.0 min<sup>-1</sup> vs. 132.1±13.0 min<sup>-1</sup>, 187.2±6.7 min<sup>-1</sup> vs. 168.8±13.1 min<sup>-1</sup> and 199.2±7.3 min<sup>-1</sup> vs. 192.2±8.7 min<sup>-1</sup>). %HRmax at LTP1 (84.6±4.5% vs. 68.6±5.0%) and LTP2 (93.0±1.5% vs. 87.7±4.0%) were sign higher in RT (p<0.01). **Conclusion:** A distinct difference and a highly individual variation in HR were found between running and cycling in man. A main finding was, that %HRmax at LTP1 and LTP2 were significantly higher in RT. Beside the well-known fact that sport specific tests are essential for a reliable HR based exercise prescription %HRmax markers are limited and the use of turn point concepts are recommended. **References:** Röcker et al. (2003) *Int J Sports Med* 24 (3), 173-178 Hofmann & Tschakert (2011) Article ID 209302. doi:10.4061/2011/209302 Wallner et al. (2014) 19th Annual Congress of the ECSS (p. 718). SportTools, Cologne

### THE EFFECTS OF INCREMENTAL JUMP STEPS ON TAKE-OFF LEG JOINT KINETICS IN BOUNDING

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**Introduction** Bounding exercises (single-leg jumps for the horizontal direction) are often used for power output improvements in plyometric training. Several studies have investigated the kinematics and kinetics in terms of bounding (Mero and Komi, 1989), but very few studies have studied the joint kinetics (Kariyama and Zushi, 2014). Moreover, no study has investigated the joint kinetics of the effect of an incremental jump step on the take-off leg in bounding from a standing position. The purpose of this study is to clarify the effect of an incremental jump step on the take-off leg during bounding. **Methods** Participants included in this study were track and field jumpers (n = 11 males; age, 20.27 ± 1.35 years; height, 177.59 ± 6.04 cm; mass, 69.82 ± 4.92 kg). Participants performed bounding from a standing position and attempted to cover the longest distance by performing seven forward alternating single-leg jumps in a series. The 1st, 3rd and 5th steps in bounding were analyzed. In order to strike the force plate at each step, start position was adjusted between each trial. Three-dimensional coordinates of 47 retro-reflective markers fixed on the body were collected by the Vicon T20 system (250 Hz); ground reaction forces were measured using force platform (1,000 Hz). Joint torque and joint power of the take-off leg were calculated using inverse dynamics. **Results and Discussion** Analysis of the sagittal plane movements revealed that ankle plantar flexion torque and knee extension torque and power increased on the take-off leg; hip extension torque and power did not. These results indicate that ankle and knee joint kinetics are more important for increasing bounding at high horizontal velocity. The hip internal torque and power exerted on the take-off leg increased, but the effect size was small. Conversely, the hip abduction torque and power increased. Additionally, the patterns of hip abduction torque and power were similar to those of the vertical and lateral ground reaction forces. Hip abduction torque and power may play an important role at high horizontal velocity by resisting the impact force (ground reaction force) and maintaining the lateral balance during bounding (Kariyama and Zushi, 2013). These results suggest that although hip abductors are more important for horizontal high-speed take-off (5th step), they may also be important for low-speed take-off (1st and 3rd steps). **References** Mero A, Komi PV. (1994). *J App Biomech*, 10, 1-13. Kariyama Y, Fujii H, Mori K, Zushi K. (2013). Proceedings of the XXXI-th Congress of the International Society of Biomechanics in Sports, Taipei, Taiwan, P01-5 ID142. Kariyama Y, Zushi K. (2014). *Japan J Phys Educ Hlth Sport Sci*, 59, 397-411.

### TECHNIQUE AND ARTISTRY IN ELITE RHYTHMIC GYMNASTS: THEIR ASSOCIATION WITH PHYSICAL FITNESS PARAMETERS

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**Introduction** Technical execution and artistry are the primary components of rhythmic gymnasts' evaluation (Rhythmic Gymnastics Code of Points, 2013-16). Although, overall performance improves with enhanced physical capacities (Hume et al., 1998) there is a need to precisely define performance components and the physical abilities that are more important in every stage of athletic development. The aim of this study was to examine the particular association between selected physical fitness parameters, technical execution and artistry in elite rhythmic gymnasts. **Methods** Eleven rhythmic gymnasts (aged 14.77±0.41 years, training experience 8±1 years) all members of the Greek national team, participated in this study. Technical execution was determined by deductions for faults in elements technique. Artistic performance score, in deductions, was the sum of the sub-scores of unity, relation between movements and music, use of space and body expression. Technical execution and artistry were evaluated by one international judge according to the International Gymnas-

tics Federation Code of Points (2013-16). The gymnasts underwent a series of physical fitness tests, (body composition, active and passive flexibility, muscular power and endurance and agility). Stepwise multiple regression analyses examined the strength of the association between technical execution and artistry scores, and physical fitness parameters. Results Multiple regression analysis indicated that sideways leg extension, hamstrings flexibility, agility, and one leg counter movement jump, accounted for 82.7% of the variance in technical deductions (adjusted  $R^2=0.827$ ,  $F=12.911$ ,  $p=.004$ ). Sideways leg extension, hamstrings flexibility, agility and one leg counter movement jump accounted for 59,3% of the variance in artistry score (adjusted  $R^2=0.593$ ,  $F= 4.648$   $p=.047$ ). Discussion It is concluded that hip joint flexibility, agility, and lower limb muscular power account for a large part of the variance of technical execution and artistry score. Although artistry is considered a matter of personal style, the results of this study highlight the importance of strength and conditioning programs for artistic competence and indicate that artistry and technique are interrelated aspects of performance in elite rhythmic gymnasts. References Hume, P.A., Hopkins, W.G., Robinson, D.M., Robinson, S.M., and Hollings, S.C. (1998). J Sports Med Phys Fitness, 33, 367-377. Rhythmic Gymnastics Code of Points-R.G. (2013-16). International Gymnastics Federation (F.I.G) Contact odonti@phed.uoa.gr

### INFLUENCES OF FASCICLE LENGTH DURING ISOMETRIC TRAINING ON IMPROVEMENT OF MUSCLE STRENGTH

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Introduction It is previously shown that effect of isometric training on muscle strength is greater at the angle where the training was performed (Kitai et al, 1989). On the other hand, there is a supersonic imaging study showing that the fascicle length (FL) during isometric contraction changes depending on both joint angle and exerted torque. Therefore, there is a need to re-examine the effect of isometric training whether the effect truly depends on joint angle or on FL. We hypothesized that by performing isometric contraction with low intensity which causes minor change in FL during contraction, we may find change in muscle strength in the angle where the FL is similar to that during training rather than in angle similar to that during training. Methods Twenty four healthy women ( $21.8 \pm 1.5$  years) participated in this study. The subjects were divided into 3 groups (training at slack position (SP), training at extension position (EP) and control groups). Plantar-flexion (PF) strength of isometric maximal voluntary contraction (MVC) and FL of gastrocnemius were measured before (Pre) and after (Post) training. MVC were measured at six positions with the ankle joint angle from  $20^\circ$  dorsiflexion (DF) to  $30^\circ$  PF at every  $10^\circ$ . FL was also measured at the six ankle positions using B-mode ultrasound in three conditions: at rest, 30%MVC and MVC, respectively. Resistance training on PF with intensity of 30%MVC was performed 3 days per week for 4 weeks with 3 sets of 20 repetitions of 3-seconds isometric contraction. The ankle joint angle during the training was placed at  $20^\circ$  PF in SP and at  $10^\circ$  DF in EP, respectively. Split-plot ANOVA using two factors (time [Pre and Post] and group [SP, EP and control]) was used to analyze interaction effects in MVC at each angle. When a significant interaction was observed, paired t-test was used as a post hoc test to determine the differences in MVC between Pre and Post at each group. Results and Discussion Split-plot ANOVA indicated a significant interaction in MVC at only  $0^\circ$  and  $10^\circ$  PF. Post hoc test showed that both MVC at  $0^\circ$  and  $10^\circ$  PF significantly increased after resistance training in SP group. There were no differences in MVC between Pre and Post in EP and control groups. FL in SP group were  $3.1 \pm 0.5$ cm,  $3.3 \pm 1.2$ cm,  $2.8 \pm 0.7$ cm and  $2.5 \pm 0.4$ cm during training and in measurements during MVC at  $0^\circ$ ,  $10^\circ$  and  $20^\circ$  PF. These results supports our hypothesis that the effect of isometric training is found at the same FL rather than the same angle as in the training. Reference 1.Kitai TA, Sale DG. Specificity of joint angle in isometric training. Eur J Appl Physiol Occup Physiol. 1989;58(7):744-8. Contact tanaka.hiroki.27w@st.kyoto-u.ac.jp

### THE CORRECTION OF CYCLISTS' TRAINING LOAD PARAMETERS IN THE FIRST WEEK OF THEIR STAY AT ALTITUDE

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Introduction. The methodology of a training which uses hypoxia in accordance with the LH-TH (live high – train high) and LH-TLH (live high - train low and high) model is well-defined (Stray-Gundersen, Levine 2008). Special attention has been paid to conditioning of the effect of a 2-3 week stay at altitude combined with various combinations of training loads. (Friedmann-Bette2008) However, the issue of selection of training loads in one week stay in the conditions of hypoxia has not been described in literature. The aim of this investigation was to determine a correction algorithm for the level of training load and heart rate in cyclists during one week training conducted at the altitude of 2000 – 2200 m above sea level. The participants of the study were MTB cyclists XCO Nationals Teams Russia and Poland (women n=8, 24,3/2.5year, 50,2/2.7kg, 159,1/6.1cm; men n=8 21,2/1.2year, 65,5/4.5kg, 176/3.5cm). After arriving at the altitude of 2250 m in the first and second day the participants did a graded incremental exercise test (GXTs) at the altitude of 2250 m and 1350 m. The GXTs test was executed on Cyclus 2 (RBM, Germany) ergometer. The first step was 1Wx1-1 b.m., which was increased by 0,5 Wxkg-1 b.m. every three minutes. In the last 30 seconds of each exercise, a grade of 20  $\mu$ l of arterialized blood was taken to sign LA (Biosen S-line, EKF, Germany). In the course of effort  $VO_2$ , VE,  $VCO_2$  was measured by means of K4b2 analyser. The heart rate monitor Polar V650 (Polar Finland) was measured HR during GXTs. The power was subordinated to aerobic threshold (LT), Farell et al.(1979), anaerobic threshold (AT) (Powers et al.1983) and  $VO_2$ max. Results. A comparative analysis of  $VO_2$ max, LT and AT of power has indicated a varied direction of changes with the increase of hypoxia. Power on LT:  $P \downarrow$ ,  $VO_2 \uparrow$ ,  $VE \leftrightarrow$ ,  $HR \leftrightarrow$ ,  $O_2HR \uparrow$ . Power on AT:  $P \leftrightarrow$ ;  $VO_2 \uparrow$ ;  $VE \uparrow$ ;  $HR \uparrow$ ;  $O_2HR \uparrow$  and max. power:  $P \downarrow$ ;  $VO_2 \uparrow$ ;  $VE \uparrow$ ;  $HR \uparrow$ ;  $O_2HR \uparrow$ . Regression equations and coefficient of determination: LT have been determined for power (intensity indicator) - LT:  $y = 1,0266x - 3,8352$   $R^2 = 0,844$ , AT:  $y = 1,0014x - 4,0523$   $R^2 = 0,956$  and max:  $y = 0,8764x + 13,024$   $R^2 = 0,9315$ . Conclusion. The character of changes of physiological indicators at the level of LT, AT and  $VO_2$  max power shows that in all cases changes in power are closely related to each other. Low value of the coefficient of determination for HR:LT:  $R^2 = 0,1891$ ; AT:  $R^2 = 0,1663$  |  $VO_2$ max:  $R^2 = 0,5131$ ) means that HR is not a good indicator of regulation of physical effort intensity in the first week of stay at altitude. Farell et al. 1979 Med.Sci.Sport Exerc.11:338-44. Powers et al. 1983 Res.Q.Exerc.Sport 54:179-82. Friedmann-Bette 2008. Scand J Med Sci Sports. 2008 8(18) Suppl 1:11-20. Stray-Gundersen, Levine. 2008 Scand J Med Sci Sports. (8);18 Suppl 1:21-8. Grant MNIŠzW RSA2 048 52

### TIME MOTION ANALYSIS OF CADET TAEKWONDO ATHLETES IN RELATION TO THE WEIGHT CATEGORY

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Introduction The relationship between fighting and non-fighting phases during Taekwondo bouts has been used to characterize physical demands of this Olympic sport (Santos et al., 2011; Tornello et al., 2013). In the literature (Santos et al., 2011) elite athletes competing in the heavy categories carried out longer non-fighting phases and shorter fighting phases with respect to those competing in the lighter cate-

gories. In considering that youth athletes compete at international level and the possible influence of the weight on the results, the aim of this research was to analyze the time activity phases of male cadet taekwondo athletes in relation to their weight category. Method Twenty-two bouts (semifinals and finals) of the 1st World Cadet Championship were analyzed according to the time activity phases proposed by Tornello et al. (2013): non-fighting (NF), fighting (F) and stoppage (S) phases. A one-way ANOVA with the weight category (light-LW, middle-MW, and heavy-HW) as a factor was applied to test differences in activity phases. Pairwise post hoc comparisons were carried out with Bonferroni adjustments. Partial eta-square was used to evaluate effect size (ES) for significant differences ( $p < 0.05$ ). Results Despite athletes competing in the heavy category showed longer (F [827,2] = 17.383;  $p = 0.01$ ; ES = 0.4) NF phases (3.7±2.9 s) with respect to their counterparts competing in the light (3.0±1.6 s) and middle (2.7±1.7 s) ones, no effect emerged for F (LW: 2.85±2.42, MW: 2.53±1.72, and HW: 2.48±1.88) and S (LW: 9.34±20.04, MW: 12.13±27.94, and HW: 11.47± 26.74) phases. Discussion The present findings indicate that youth athletes with high body mass could require longer NF phases to recover between fighting (Santos et al., 2011), suggesting that this difference could be due to the higher body mass of heavy competitors who spend more energy and need more rest time with respect to lighter competitors. Therefore, coaches should consider appropriate to structure simulated training allowing longer resting time periods for heavy athletes. References Santos VG, Franchini E, Lima-Silva AE. (2011). *J Strength Cond Res* 25, 1743-1751. Tornello F, Capranica L, Chiodo S, Minganti C, Tessitore A. (2013). *J Strength Cond Res*, 27, 223–228.

### ACUTE NEUROMUSCULAR FATIGUE INDUCED BY REPEATED DIRECTION CHANGES DOES NOT INFLUENCE FREE THROW ACCURACY IN AMATEUR BASKETBALL PLAYERS

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Introduction Performance in basketball is determined by a combination of physical and technical aspects (Ziv and Lidor, 2009). It has been recently demonstrated that free throw (FT) accuracy can be negatively influenced by exercise intensity (HR ~80% HRmax) preceding FTs (Padulo et al., 2014). However, the acute effect of lower limb neuromuscular fatigue on FT accuracy has yet to be investigated. The aim of this study was to determine the acute effect of neuromuscular fatigue induced by a basketball specific exercise, repeated changes of direction (COD), on FT accuracy. Methods Twenty-one amateur basketball players (age: 26.2±8.1 yrs, height: 185±10 cm, weight: 81.6±13.8 kg) were randomly assigned to exercise (EG) or control group (CG). All players performed 4 series of FT with the aim of scoring as many FT as possible in a 10-sec period. The four series of FT were separated by 30-s of rest for CG and 30-s of repeated COD for EG. COD exercise comprised of 180° turns performed repeatedly on a 7 m course following pre-determined acoustic signals. The COD exercise increased in intensity following each series of FT. All subjects performed countermovement jumps (CMJ) on a Force plate (Quattro Jump, Kistler, Switzerland) prior to the first (PRE), and following the last (POST), series of FT. Results The CMJ performance was reduced only in EG (time x group interaction:  $p=0.001$ ,  $p=0.009$  and  $p=0.023$  for height, peak power and peak force respectively). In EG the CMJ indices were significantly reduced from PRE to POST measures (height: 45.5±4.2 vs 41.6±4.1 cm; peak power: 51.5±5.7 vs 47.8±5.6 W/kg; Peak Force: 2132±370 vs 2002±287 N, all  $p<0.05$ ). No differences in CMJ capacity were observed in CG. The number of FT shots taken increased significantly between PRE and the following three series of FT in both groups ( $p=0.024$ ) without any significant difference between them ( $p=0.467$ ). However, the number of successful FT was unvaried across FT tests as well as between groups ( $p=0.743$  and  $p=0.179$  respectively). Discussion Acute lower limb neuromuscular fatigue induced by COD exercise was not found to significantly impact upon FT accuracy in amateur basketball players. Future studies should further investigate the effect of fatigue induced by basketball specific exercises on FT accuracy and how exercise intensity can influence technical ability. References Padulo J, Attene G, Migliaccio GM, Cuzolin F, Vando S, Ardigo LP (2014). *J Sports Sci*, Dec 20:1-5. [Epub ahead of print] Ziv G, Lidor R (2009). *Sports Med*, 39(7), 547-68. Contact [davide.feroli@unimi.it](mailto:davide.feroli@unimi.it)

### COMPARISON METHODS FOR CALCULATING ANAEROBIC LACTATE THRESHOLDS IN MIXED MARTIAL ARTS COMPETITORS

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Introduction. Fighting and training in MMA require comprehensive physical preparation utilizing aerobic and anaerobic metabolic changes that determine athlete's special endurance. (Lenetsky, Harris 2012) The study aimed to determine the differences between VAT values calculated with analysing curve concentration blood lactate (LA) such as methods LTloglog (Beaver et al. 1985), LTvisual (Lundberg et al. 1986), LTΔ1 (Coyle et al. 1984), LT4.0 (Heck et al. 1985), LTD-max (Cheng et al. 1992). Methods. In investigation participated competitors MMA (n=22), age 27.5(2)years, height 179(3)cm, body mass 83.1(5.8)kg, VO2max 56.9 (5.4) ml·kg<sup>-1</sup>·min<sup>-1</sup>, length of training experience 8.6(1.8) years). The athletes were in preparation period before competition. The incremental exercise test was executed on the treadmill Saturn (HP Cosmos, Germany). The 1-st speed was 8 km h<sup>-1</sup> and increased every 3 minutes by 2 km h<sup>-1</sup>. In last 30 the seconds of every exercise grade was taken 20 µl of arterialized blood to the sign LA (Biosen S-line, EKF, Germany). Exercise intensity (VAT) at the lactate anaerobic threshold were determined using software (Newell et al. 2007). Results. VAT values obtained from all methods applied to analyse the blood lactate curve were statistically significantly correlated. Four moderate correlations were found between the values obtained from LTvisual – LT4 (0.65,  $p<0.01$ ), LTvisual – LTΔ1 (0.52,  $p<0.05$ ), LTloglog – LTΔ1 (0.69,  $p<0.001$ ), and LTΔ1 – LTD-max (0.64,  $p<0.001$ ). Highly correlated results were obtained from LTvisual – LTloglog (0.74,  $p<0.001$ ), LTvisual – LTD-max (0.87,  $p<0.001$ ), LTloglog – LT4.0 (0.76,  $p<0.001$ ), LTloglog – LTD-max (0.75  $p<0.001$ ), and LTΔ1 – LTD-max (0.80  $p<0.001$ ). A very high correlation was found to exist between VAT values generated by LT4.0 and LTΔ1 (0.91,  $p<0.001$ ). Regression equations for determining running velocities at the lactate anaerobic threshold calculable with LT4.0 using the results of LTVisual, LTloglog, LTΔ1, and LTD-max ( $y=9.54+0.381*LTvisual$ , SEE .873;  $y = 10.6 + 0.357*LTloglog$ . SEE .761;  $y = 5.49 + 0.714*LT \Delta 1$ , SEE .566;  $y = 5.84 + 0.669*LTD-max$ , SEE .674. Conclusion. Differences between VAT values obtained from each method described herein suggest that special attention should be given to the individualization of training. The proposed regression equations are able to convert the results as produced by each of the methods used to calculate the lactate anaerobic threshold to make them comparable with the result of the LT4.0 method. This approach allows training intensity to be programmed according to the same criterion. References: Newell et. al. *J.Sports Sci*;2007;25(12):1403-1409. Lenetsky, Harris, *Strength Cond J*. 2012;34(1):32-47. Grant MNISZW RSA2 048 52.

### THE RELATIONSHIP BETWEEN EXERCISE OF INTENSITY AND BLOOD LACTATE CONCENTRATION IN RUNNING FINESSES WITH CONTACT AND WITHOUT CONTACT.

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**Introduction** All Players require various kind of fitness in open-skill sports, such as soccer, basketball, handball and rugby football. Collision in the game spends a lot of energy and requires particular fitness for players. Coaches have to design effective training sessions or similar situations for games. Because collision sports such as rugby football consist of running and contact performance in the game, players must possess the same physical activities. However, running fitness training has been done for enhancing their fitness. The purpose of this study was to reveal the relationship between exercise of intensity and blood lactate concentration in running fitnesses with contact and without contact. **Methods** The participants were 8 rugby union players, (4 FWs and 4 BKs; mean±S.D. age, 20.4±0.69 years). Participants competed in two fitness test, 400m run, and 180m run with 4 contacts of tackle and wrestling (approximately 20seconds). Heart rate was measured to investigate intensity of exercise (at rest, after test immediately, after 3mins and 7mins). Blood lactate concentration (at rest, after 3mins and 7mins) was measured to investigate the ability of anaerobic exercise. **Results** The results showed that blood lactate concentration for running fitness test with contact were higher than without contact after 3mins ( $p<.01$ ), whereas HR for running with contact is significantly lower than without contact ( $p<.01$ ), however the exercise periods were almost same (61.8s for non-contact and 61.7s for with contact). **Discussion** The results indicated that running with contact could improve their anaerobic capacity more than running without contact. Because FWs player don't have enough running ability, it is hard to reach anaerobic threshold. Contact performance such as tackle and wrestle is more likely to generate high power for FWs, whereas BKs players are not as strong in contact than FWs. Some players do not have enough contact skill in high intensity training, so it will be difficult to improve high power fitness accurately. This study suggests that coaches should consider abilities and skill level of players for fitness training with contact.

### DISSOCIATED TIME COURSE OF NEUROMUSCULAR RECOVERY BETWEEN SINGLE AND MULTI-JOINT EXERCISES IN HIGHLY RESISTANCE TRAINED MEN

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**Introduction** Reduction of muscle strength for several hours or days (i.e., 8 to 96 hours) after training is primarily associated with muscle damage (Nosaka & Newton, 2002; Nosaka et al., 2005; Roth et al., 1999). However, no study has investigated the muscle damage and the time course of peak torque (PT) and muscle activation responses after multi- and single-joint exercises of the elbow flexors in highly resistance trained subjects. Thus, the purpose of this study was to compare the time course of muscle activation and peak torque after exercise-induced muscle damage performed with multi- and single-joint exercises. **Methods** Eleven resistance trained males ( $24.5 \pm 5.5$  years;  $175.1 \pm 5.0$  cm; mass:  $81.8 \pm 9.1$  kg) performed, in a counterbalanced order, 8 sets of 10 unilateral repetition maximum (RM) of multi-joint (i.e. seated row) and single-joint (i.e. biceps preacher curl) exercises using the contralateral arm. Rest intervals were 120 seconds between sets and 10 minutes between exercises. Isometric peak torque (PT) of the elbow flexors, and the surface electromyography (sEMG) of the biceps brachii were collected at baseline (PRE), 10 minutes, 24, 48, 72 and 96 hours after each exercise protocol. Comparison between different exercise protocols was performed using two-way repeated measures ANOVA (2 protocols x 6 time-points). **Results** For PT, there was significant interaction between exercise protocols. PT decrease was greater ( $P<0.05$ ) 10 min after single-joint (26.8%) when compared to multi-joint (15.1%). In addition, PT was less (8.4%) than baseline at 24 hours after the single-joint exercise ( $P<0.01$ ), whereas peak torque returned to baseline levels at 24 hours after the multi-joint exercise. For root mean square (RMS), there was no significant interaction between exercise protocols. However, there were significant main effects for time-points (10 minutes < PRE, 24h, 48h, 72h and 96h,  $P<0.05$ ). **Discussion** Our results showed that the muscle activation was not different between protocols although isometric PT was recovered at 24h after exercise only for the multi-joint. In addition, for the same level of muscle activation, torque production at 10 minutes after multi-joint exercise was greater than single-joint exercise protocol. Thus, our results suggest greater muscular efficiency after exercise-induced muscle damage performed with multi-joint when compared to single-joint exercise. **References** Nosaka K and Newton M. (2002). *J Strength Cond Res / NSCA*, 16, 202-208. Nosaka K, Newton M, Sacco P, et al. (2005). *Med Sci Sports Exerc*, 37, 746-753. Roth SM, Martel GF, Ivey FM, et al. (1999). *J Appl Physiol*, 86, 1833-1840. Contact saulosoares26@gmail.com

### AGREEMENT BETWEEN VMAX29 AND THE NEW BREATH-BY-BREATH RESPIRATORY SYSTEM VYNTUS CPX DURING MAXIMAL INCREMENTAL EXERCISE

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**Introduction** Automated metabolic gas analysis systems are widespread devices in exercise physiology (Macfarlane, 2001). As a good practice, a brand new device should be tested for validity and reliability and being in good agreement with previous, well known and validated devices. Aim of this study was to compare respiratory data collected using a validated VMAX29 system and a Vyntus CPX. **Methods** Ten subjects performed a maximal incremental exercise test ( $25 \text{ W}\cdot\text{min}^{-1}$ ) on a cycle ergometer while respiratory data were simultaneously collected and analyzed using two different devices (VMAX29 and Vyntus CPX). The agreement between the two systems in regards to  $\text{VO}_2$ ,  $\text{VCO}_2$  and  $\text{VE}$  during the whole test and at exhaustion were investigated through the Intraclass Correlation Coefficient (ICC), coefficient of variation (CV) and Bland and Altman plot (Bland and Altman, 1986). Differences for values at exhaustion were tested by paired t-test. **Results** During the whole maximal incremental exercise, ICC values for  $\text{VO}_2$  (0.997),  $\text{VCO}_2$  (0.996) and  $\text{VE}$  (0.997) were very high. The typical variation between the two systems, expressed as a CV, was low for all the parameters (1.9% for  $\text{VO}_2$ , 2.4% for  $\text{VCO}_2$ , and 2.0% for  $\text{VE}$ ). Good agreement was confirmed using the Bland and Altman plots: mean bias  $\text{VO}_2$   $-92 \pm 105 \text{ ml}\cdot\text{min}^{-1}$  (limits of agreement  $-298$  and  $105$ ),  $\text{VCO}_2$   $63 \pm 106 \text{ ml}\cdot\text{min}^{-1}$  (limits of agreement  $-145$  and  $271$ ) and  $\text{VE}$   $-1 \pm 2 \text{ L}\cdot\text{min}^{-1}$  (limits of agreement  $-5$  and  $3$ ). At exhaustion, no significant differences were detected between the two systems for  $\text{VO}_2$  ( $p=0.241$ ),  $\text{VCO}_2$  ( $p=0.793$ ) and  $\text{VE}$  ( $p=0.291$ ), nevertheless slightly lower ICCs (0.929, 0.974 and 0.936 for  $\text{VO}_2$ ,  $\text{VCO}_2$  and  $\text{VE}$  respectively) and higher CVs (3.4%, 3.6%, 2.8% for  $\text{VO}_2$ ,  $\text{VCO}_2$  and  $\text{VE}$  respectively) were detected. Bland and Altman plots confirmed these tendencies at exhaustion: mean bias  $\text{VO}_2$   $-97 \pm 242 \text{ ml}\cdot\text{min}^{-1}$  (limits of agreement  $-571$  and  $378$ ),  $\text{VCO}_2$   $24 \pm 275 \text{ ml}\cdot\text{min}^{-1}$  (limits of agreement  $-516$  and  $564$ ) and  $\text{VE}$   $-2 \pm 5 \text{ L}\cdot\text{min}^{-1}$  (limits of agreement  $-12$  and  $9$ ). **Discussion** The results of this study showed an overall good agreement between the Vyntus CPX and the widespread VMAX29. The new Vyntus CPX and the VMAX29 gave very similar values for  $\text{VE}$  while, albeit very small,  $\text{VO}_2$  was inclined to be higher and  $\text{VCO}_2$  lower for the Vyntus CPX. In spite of different hardware,  $\text{O}_2$  analysers (paramagnetic for VMAX and fuel cell for

Vyntus) and ventilator transducer (mass flow meter for VMAX29 and turbine for Vyntus), the two devices might be used interchangeably without compromising the consistency of the results. References Macfarlane D.J. (2001). *Sports Med*, 31 (12), 841-861 Bland J.M. and Altman D.G. (1986). *Lancet*, 1, 307-310 Contact domenico.carlomagno@mapeisport.it

### SHUTTER GLASSES AS A TRAINING TOOL IN TENNIS – CHANGES IN EYE-HAND COORDINATION ACCORDING TO FREQUENCY AND DUTY RATIO

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**Introduction** Shutter glasses seem to be a tool for training visual functions in the context of sports vision training to increase movement coordination. Several studies discussed effects and non-effects of training with shutter glasses e.g. within coincidence anticipation (Smith & Mitroff, 2012; Reichow et al., 2010), motion cognition or short-time memory (Appelbaum et al., 2011 and 2012). No investigation, however, justifies training and strobe settings yet. Based on the necessity of an adequate load dosage to allow training effects, the present study intends to assess which strobe settings lead to a significant decrease of target hit precision in tennis. **Methods** With a total number of 22 tennis players (18m, 4f, mean age=23.6, SD=+/-2.7 years) the target hit precision (precision of eye-hand (bat) coordination) was conducted. The tennis players had to return the balls played to them by a ball machine (25 balls for each test) using the forehand volley and to make direct hits to a "bull's eye" (high scores stand for a high target hit precision). The results with different (randomized) conditions (strobe rates level 2=5.3 Hz, level 5=2.3 Hz, level 8=1.0 Hz; duty ratio level 2=89 ms, level 5=343 ms, level 8=912 ms) of currently used shutter glasses (Nike Vapor Strobe) and without the glasses have been compared. Results High level tennis players reached better target hit precision scores "without the glasses" compared to lower level tennis players by trend (75.0+/-16.4 vs. 64.9+/-17.4; 2p>0.05). By increasing level (lower frequency and higher duty ratio) the tennis specific target hit precision scores decreases significantly ("without the glasses"=70.0+/-17.3, level 2=54.5+/-15.9, level 5=41.7+/-22.7, level 8=44.5+/-24.3; p<0.001). The scores with the shutter glasses (at levels 2, 5 and 8) were all significantly less than "without the glasses" (2p<0.001). The variability of the target point (coefficient of variation) increased playing with the shutter glasses ("without glasses"=24.8 %, level 2=29.1 %, level 5=54.4 %, level 8=54.7 %). **Discussion** Lower frequency and higher duty ratio lead to increasing perceptual stress for the eye-hand (bat) coordination in a tennis specific situation. No discrete levels for changes in performance were found. The levels 5-8 seem to be adequate demands to develop a tennis specific training program with shutter glasses. However, efficiency of such a (future) sport specific training program has to be analyzed first before establishing shutter glasses as an effective training method. **References** Appelbaum LG, Cain MS, Schroeder JE, Darling EF, Mitroff SR (2012). *Atten Percep Psychophys*, 74(8), 1681-1691. Appelbaum LG, Schroeder JE, Cain MS, Mitroff SR (2011). *Front Psychol*, 276(2), 1-13. Reichow A, Citek K, Blume M, Corbett C, Erickson G, Yoo H (2010). *J Vis*, 10(7), 1031. Smith TQ, Mitroff SR (2012). *IJES*, 5(4), 344-353. Contact gernot.jendrusch@rub.de

### A STUDY OF HYPOXIC EXPOSURE AND TRAINING ON HAEMATOLOGICAL VARIABLES, PP, VO2MAX

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**Hypoxic exposure and training** in this study was to investigate the hypothesis that the various models 'live and/or sleep high: train low(LHTL)' by way of 4 weeks in elite level tennis players. Sixteen well-trained tennis players were divided into two groups: SITH(sprint intermittent hypoxic, n=8) and CON(control, n=8). SITH group were exposed to normobaric hypoxic chamber at fixed altitude (normobaric hypoxic chamber; b-cat, SIEMENS, Netherlands). The experimental group which SITH (SIT with hypoxic) from 2,500m to 4,000m performed the graded elevation every 500 m increased by the week five times a day, two times four weeks treated to a SIT (sprint interval training) and three hours of exposure in hypoxic chamber (simulated normobaric hypoxic). The CON (control) was conducted same period and methods without exposure to hypoxia that a SIT at sea level Each interval training session was performed in a laboratory on the treadmill(Quak b2, Italy) and bicycle ergometer(Excaliber, Lode) in normoxic or hypoxic conditions for the each group, respectively. The each group performed warm-up and cool-down plus recovery from each interval in hypoxic conditions. All blood variables were observed and this examination was conducted per week. As a results, the haematological variables were Hb and Hct compared Pre with the treatment at the end of 4,000 m has been shown to significantly increased in both groups respectively(p<.05, p<.01; vs. Pre). Aerobic exercise capacity related variables that Time was SITH has been shown to significantly increased at 4,000 m(p <.05; vs. Pre). Also, VO2max was SITH has been showed increased in the same period a tendency(p=.072). Anaerobic exercise capacity related variables that PPI(W) was both groups increased significantly at 4,000 m(p <.05; vs. Pre), and PP (W / kg) was CON group has been showed increased in the same altitude a tendency, whereas SITH group has been showed increased at 3,500 m and 4,000 m respectively(p<.05; vs. Pre). Therefore, this study, unlike previous studies with similar positive results as a follow-up study will be contribute to the attainment of a higher value.

### INTERDAILY VARIATIONS AND ACCURACY OF MEASUREMENT OF BODY COMPOSITION USING BIA ANALYZERS IN ATHLETES

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**Introduction** Body composition is often used in the diagnostics of athletes. However, diagnostics often use repeated measurements performed in greater time intervals and therefore the mere knowledge of the error of measurement found on the basis of immediately repeated measurements is insufficient. The aim of the study is to analyze the changes in the body composition parameters measured during a workweek and to determine the size of the error of measurement. **Methods** The research group included 48 students of physical education (21.42±1.38 years) engaged in sports at the performance or professional level. The measurements took place every day during the workweek. The participants did not perform any organized physical activity during the week. The measurement was performed using the Nutriguard-MS multi-frequency analyzer (DataInput, Germany) and the Tanita-418 MA monofrequency analyzer (Tanita, Japan). To evaluate the differences of the means, we used the repeated measures (ANOVA). To assess objective significance, we used Eta-squared. To express the size of the error of measurement in the weekly analysis, we used the typical error of measurement (TE) (Hopkins, 2000). The parameters measured were body mass (BM), body fat (BF), total body water (TBW) and fat free mass (FFM). Results BF (%), kg) and TBW (%) measured by Tanita showed a statistically significant difference in measurements on Monday and Friday. Practical significance was not confirmed in any of the parameters. The TE values calculated for the parameters measured by Nutriguard were as follows: BM 0.44 kg, FFM 0.88 kg, BF 0.81 kg and 1.09%, TBW 0.64 kg and 0.80%. The TE values measured by Tanita were: BM 0.44 kg, FFM 0.86 kg, BF

0.68 kg and 0.90%, TBW 0.63 kg and 0.66%. Discussion The TE values we found are higher than the values stated in immediately consecutive repeated measurements (Macfarlane, 2007). This difference is given by the timing relationship that we chose for our study. The size of TE grows with the increasing interval of repeated measurements (Vicente-Rodríguez et al., 2012). However, the found TE values show very little fluctuation during the week. When interpreting the results of repeated measurements in diagnostics, we recommend using only the values that exceed the level of the typical error of measurement. References Hopkins WG. (2000). Measures of Reliability in Sports Medicine and Science. *Sports Medicine*, 30, 1–15. Macfarlane DJ. (2007). Can bioelectric impedance monitors be used to accurately estimate body fat in Chinese adults? *Asia Pacific Journal of Clinical Nutrition*, 16, 66–73. Vicente-Rodríguez G et al. (2012). Reliability and Intermethod Agreement for Body Fat Assessment among Two Field and Two Laboratory Methods in Adolescents. *Obesity*, 20, 221–228. Contact petr.kutac@osu.cz

### KAATSU TRAINING MODIFIES THE MEAN AND MAXIMUM BLOOD FLOW VELOCITY IN HEALTHY SUBJECTS

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**INTRODUCTION** Strength training with vascular occlusion (KAATSU training), has been investigated with the purpose of increasing muscle mass and strength of practitioners of strength training (Sato, 2005). Despite a growing number of studies, there are still many doubts about the method, especially related to influence of muscle strength in the bloodstream. The objectives of this study were to investigate the effects of KAATSU training on muscle strength and arterial circulation. **METHODS** Eleven male individuals physically active aging  $20.72 \pm 2.05$  years underwent to an eight-week training protocol (strength training with vascular occlusion on knee extension and elbow flexion) with 20% of maximum voluntary contraction. Muscle strength was assessed (Kg) using the Brzycki (1993) equation in three times of the training program and arterial blood flow velocity (cm/s) and systolic blood pressure (SBP) were recorded by using Doppler (Nicolet Versalab®) at the beginning and end of the protocol. Data were analyzed using the software GraphPad Instat® and PRISM® 6 (La Jolla, USA), using descriptive statistics, Shapiro-Wilk test, ANOVA for repeated measures and Tukey-Kramer to detect differences ( $p \leq 0.05$ ). **RESULTS** Results revealed no differences in SBP of upper and lower limbs in the beginning and at the end of the experimental protocol. However, increases of strength in both lower limbs, right ( $p < 0.02$ ) and left ( $p < 0.01$ ) comparing the pre and post training and increases in maximum ( $p < 0.0001$ ) and mean blood flow velocity ( $p < 0.03$ ) were found for both arms. **DISCUSSION** There were no differences in SBP of upper and lower limbs, indicating that strength training with vascular occlusion does not alter SBP. These results corroborate the findings of Polito et al. (2003), which concluded that the intensity of strength training can influence the duration and the magnitude of the load hypotensive effect. Where sessions with intensity around 70% of 1RM, would promote reductions of SBP, while sessions with low-medium intensity 40-50% of 1RM, would provide a less sensitive reductions of SBP, but this study was carried without the use of vascular occlusion. Nevertheless, differences in strength and maximum and mean blood flow velocity were found for the upper limbs. **REFERENCES** Brzycki M. Strength testing: predicting a one-rep max from repetitions to fatigue. *JOPERD*. 1993; 64: 88-90. Polito, M. D.; Farinatti, P. T. V. Considerações sobre a medida da pressão arterial em exercícios contra-resistência. *Revista Brasileira de Medicina do Esporte*. 2003; 9: 25-33. Sato, Y. The history and future of KAATSU Training. *International Journal of Kaatsu Training Research*. 2005; 1: 1-5. CONTACT enrico@usp.br

### CAN THE "TWO-STEP TEST" EVALUATE PHYSICAL CAPACITY?

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**Background & Objective:** Elderly people often suffer dysfunction of musculoskeletal system. Several tests to examine the dysfunction have been proposed. The "two-step test" is one of those, which is to measure the sum length of two steps when asked to walk with maximum strides. The aim of this study is to investigate whether the "two-step test" can evaluate physical capacity including muscle strength, standing balance, and suppleness of the lower limbs, which are the main factors for dysfunction of musculoskeletal system. **Materials & Methods:** One hundred subjects (52 males and 48 females) were involved in this study. Average age was  $51 \pm 11$  years, and average BMI was  $27.8 \pm 6.6$  kg/m<sup>2</sup>. After the "two-step test" was carried out, following five additional tests to evaluate physical capacity were performed: 1) grip strength, 2) quadriceps strength, 3) 30-sec. chair-stand test (CS30), 4) one leg stand test with open eyes, 5) finger-floor distance (FFD). CS30 is a test to count the number of times to repeat standing-up from and sitting-down on a fixed chair within 30 seconds. In 18 out of the 100 subjects, 24-hour physical activity was also monitored using portable accelerometer. The data were standardized by age, sex, body height and BMI, and the correlation between the results of "two-step test" and those of above mentioned physical tests were analyzed. **Results:** The average sum length of two steps (results of the "two-step test") was  $1.51 \pm 0.14$  (divided by body height, in order to standardize the data). Significant positive correlations were observed between the results of "two-step test" and those of all the physical tests ( $p < 0.05$ ); grip strength, quadriceps strength, CS30, one leg stand with open eyes, and FFD. A positive correlation was also observed between the results of "two-step test" and intensity of physical activity in the 18 subjects who monitored 24-hour physical activity ( $p < 0.05$ ). **Conclusion:** This study suggests that the "two-step test" is a simple and useful method to evaluate patient's physical capacity, and has a possibility to become a standard test in the "hurry-scurry" daily medical practice.

### VIBRATION TRAINING IN INDOOR BOULDERING: EFFECTS ON STRENGTH AND ENDURANCE.

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**INTRODUCTION:** Indoor bouldering (IB) consists of low height climbing sequences with grip strength and endurance as key factors. Despite the increasing popularity and competitiveness, limited research has been conducted on sport-specific training methods. Therefore, the aim of this study was to investigate the use of fingerboards in the presence (VB) and absence (FB) of vibration stimulation to increase grip strength (GS) and climbing time to exhaustion (CTE). **METHODS:** Thirty-four male boulderers ( $25 \pm 4$  y;  $1.78 \pm 0.1$  m;  $70 \pm 5$  kg;  $6 \pm 2$  yrs climbing; 7b Fb mean ability) were randomly allocated to a 4-week VB (n=11), FB (n=11), or IB (n=12) training regimen with three sessions of 150 min per week. VB and FB involved finger hangs on a Transgression fingerboard (GER), fixed at head height on a vibration plate (Power Plate Classic; 2 mm amplitude; 40 Hz frequency) for vibration stimulation in VB. IB involved bouldering at individual ability level. Pre- and posttests with a 48 h rest prior data collection involved body weight (BW), perceived physical state (PEPS), handheld dynamometry to assess GS, and the repeated ascent until exhaustion of a 4 m high bouldering route with 10 bolt-on holds to determine CTE. **RESULTS:** GS increased significantly ( $p < .001$ ) in VB (+7.3%) and FB (+5.0%), but not in IB (+2.6%;  $p = .109$ ). Significant greater GS increases were found

in VB compared to IB ( $p = .045$ ) with, however, no significant ( $p = .656$ ) differences between VB and FB. CTE increased significantly in VB (+31.3%;  $p < .001$ ), but not in FB (+10%;  $p = .288$ ) and IB (+6.6%;  $p = .298$ ). No significant ( $p > .05$ ) changes in BW and PEPS were observed between the pre- and posttests and the training groups. **DISCUSSION:** Our findings indicate that VB and FB are highly effective in increasing GS. Both involve isolated grip positions that are worked maximally to the point of muscle failure, making GS gains to occur in a relatively short period of time. In contrast, IB involves multiple grip sizes and shapes, so the isolation of single grip positions cannot occur to the same extent as with VB and FB. Moreover, our results suggest that VB is highly effective in increasing CTE. The different findings between VB and FB may be explained by the additional vibration stimulus in VB, whereas the limited number of climbing moves may explain the insignificant findings in IB. **REFERENCES:** La Torre A, Crespi D, Serpiello FR, Merati G (2009). Heart rate and blood lactate evaluation in bouldering elite athletes. *J Sports Med Phys Fitness*, 49(1), 19-24. Macdonald JH, Callender N (2011). Athletic profile of highly accomplished boulderers. *Wilderness Environ Med*, 22(2), 140-143. White DJ, Olsen PD (2010). A time motion analysis of bouldering style competitive rock climbing. *J Strength Cond Res*, 24(5), 1356-1360. CONTACT: j.medernach@dshs-koeln.de.

### NEW BIOELECTRICAL IMPEDANCE ANALYSIS EQUATIONS FOR AMERICAN ADOLESCENT ATHLETES

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**Introduction** Bioelectrical impedance analysis (BIA) is a widely used commercial method of predicting body fat composition in the United States. It is convenient, easy to administer and widely accepted by the public. However, there are known errors associated with the use of BIA. Therefore, the purpose of this study was to develop a new set of gender-specific equations for predicting body composition in adolescent athletes using BIA. **Methods** Fifty-one American student athletes (25 males [age =17.36±1.15yrs] and 26 females [age=17.54±1.56yrs]) ages 14 through 19 underwent the experimental procedures. Using the Athletic IQ (AIQ) scale and stadiometer (Canton, MA USA), height and body mass were determined. The AIQ BC-100 was used to determine impedance, phase angle, resistance and reactance. Participants performed this test while hydrated (specific gravity under 1.025) and arms kept parallel to the ground. Percent body fat using hydrostatic weighing was used as the criterion. Body density was determined by using the average of the three heaviest underwater weights. Results Body mass Index (BMI) and impedance were significant predictors in each gender-specific equation. Age was a significant contributor to the female equation but not the male equation. Phase angle, resistance and reactance were not significant contributors in the development of either equation. Male equation: Body fat % = -68.48+1.81(BMI) +.066(Impedance)  $r=0.79$ ,  $r^2=0.63$ ,  $p<0.001$  SEE 4.37 Female equation: Body fat % = -4.33+1.3(BMI)-.68(AGE) +.013(Impedance)  $r=0.81$ ,  $r^2=0.66$ ,  $p<0.001$  SEE 3.40 **Discussion** Early research by Jackson et al. 1988 noted a high reliability between BIA, skinfold and hydrostatic weighing for body composition. More recently in a review of the literature of 50 published studies, it was cited that BIA is a practical method to estimate body fat percentage in children and adolescents but validity and measurement error concerns are still present (Talma et al., 2013). This study successfully generated new gender-specific BIA prediction equations for body composition in American adolescent athletes using hydrostatic weighing as the criterion. **References** Jackson A, Pollock M, Graves J, Mahar M. (1988) *J Appl Physiol* 64(2), 529-534. Lyra C, Lima S, Lima K, Arrais R, Pedrosa L. (2012) *Ann Hum Biol* 39(4), 275-280. Talma H, Chinapaw M, Bakker B, HiraSing R, Terwee C, Altenburg T. (2013) *Obes Rev* 14(11), 895-905 Contact jroberts@edinboro.edu

### COMPARISON OF ENERGY EXPENDITURE AND HEART RATE ACCORDING TO SELF-SELECTED, SELF-PERCEIVED AND CONTROL WITH PERSONAL TRAINER DURING AEROBIC EXERCISE

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**Introduction** The higher walking speed self-selected and the greater  $VO_2$  that lead to a greater energy cost (Kleverton Krinski, et al., 2012). Self-paced exercise may improve adherence to exercise programs among overweight and obese adults (Williams, D.M., et al., 2014). And imposing a speed that is just higher than what overweight women would have selected led to a significant decline in reported pleasure (P, Ekkekakis, et al., 2006). But, enforced constant paced exercise presents a significantly greater physiological challenge than self-paced exercise (Lander, P. J., et al., 2009). The purpose of this study was to compare on energy expenditure and heart rate according to the exercise ways of self-selected, self-perceived THR and exercise with personal trainer during bicycle aerobic exercise for 30 minutes. **Methods** 6 male college students (23±1.0year, 174±1.4cm, 70±5.2kg, 17.7±3.36%BF) participated voluntarily on this experiment. They were to engage in a 30-min bout of bicycle aerobic exercise (5min: warm-up, 20min: main exercise, 5min: cool down). All participants measured their heart rate reserved (HRR). And then figured target heart rate (THR) with their respective %70HRmax respectively. They performed (self-selected: SS, self-perceived THR: SP and control with the personal trainer: CPT) in the same amount of time, repeatedly. Subjects were measured energy expenditure (EE) and mean heart rate (mHR) at the point of warm-up, main exercise, and cool down. We analyzed it using independent t-test with SPSS/PC ver.18.00. Statistical significance was defined as  $p<.05$ . Results In the main exercise section, EE and mHR in CPT method was markedly higher than SS and SP. It showed significant difference ( $p<.001$ ). Meanwhile, in the whole 30-min exercise, mHR in CPT way was the highest. It demonstrated a statistically noticeable difference ( $p<.001$ ). **Conclusion** On the basis of these results, we have to be assisted with personal trainer, when exercising. Self-paced exercise may improve adherence to exercise programs among overweight and obese adults (Williams, D.M., et al., 2014). But normal person showed the different results in this study. These findings indicate that the exercise using the optimal THR under the personal trainer is expected to be more efficient than self-selected, and self-perceived exercise method. **References** Lander P. J., Butterly R. J., Edwards, A. M. (2009). *Br J Sports Med*. 43(10):789-95. Williams, D. M., Dunsiger, S., Miranda, R. Jr., Gwaltney, C.J., Emerson, J. A., Monti, P. M., Parisi, A. F. (2014). *Ann Behav Med*. Sep 16. P. Ekkekakis, E. Lind (2006). *International Journal of obesity* 30. 652-660. Kleverton Krinski, Hassan Mohamed Elsangedy, Maressa Priscila Krause, Luciana Da Silva Timossi, and Sergia Gregoria da Silva (2012). *Acta Scientiarum Health Sciences*, 34(2), 145-150. lkookcook@smu.ac.kr

### ACTIVE AND PASSIVE FLEXIBILITY OF THE LOWER LIMBS IN RHYTHMIC GYMNASTICS ATHLETES IN DIFFERENT COMPETITIVE LEVELS

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**Introduction** Flexibility is considered one of the main characteristics requested by the practice of Rhythmic Gymnastics (RG). According to Lisitskaya (1995) without an adequate level of flexibility, is difficult to improve the technique, educate the expressivity and the lightness of



the movements. According to Nuñez (2005) the flexibility is the capacity that permits to perform movements with high performance level in gymnastics. A gymnast shows restricted and limited movements, when she has insufficient mobility in the joints. Therefore, the aim of this study was to study the level of Active and Passive Flexibility in Lower Limbs (LL) of Portuguese national level gymnasts when compared to international level gymnasts. Sample For this study we studied in total 30 RG gymnasts with  $13,73 \pm 0,17$  years old. Methods The evaluation was done using the flexibility Test Battery for LL (FIG, 2010) that includes the evaluation of seven specific movements in RG, executed by both lower limbs: preferred lower limb (PLL) and the not preferred (NPLL). The gymnasts were filmed for each proposed element for later appreciation in a scale of five levels (0-4). The data was treat using Parametric tests (T Test) and Nonparametric (Mann-Whitney Test). To compare the data from the same gymnast we used the Nonparametric test-Wilcoxon Test for paired samples. Results and conclusions The passive flexibility with the PLL, in the international level registered higher results than the national level in 75% of the tests. For the active flexibility ewe registered better results in the international level gymnasts, but only in 33,3% of the tests. Concerning the seven flexibility tests performed, we concluded the results for the both national and international levels were similar results. When compared the flexibility levels between the PLL and NPLL results shown that 86,7% of the Portuguese junior gymnasts presented flexibility differences between the LL equal or superior to 15%. References FIG. (2010). Age group development program for rhythmic gymnastics sample physical testing program. Lausanne: Federation International de Gymnastique. Lisitskaya, T. (1995). *Gimnasia Rítmica. Deporte & Entrenamiento*. Barcelona: Editorial Paidotribo. Núñez, A. M. G. (2005). Algunas consideraciones acerca del entrenamiento de la Flexibilidad en el Taekwondo [electronic version]. *Educación Física y Deportes, Revista Digital*, 10(87). Consult. 15 March 2011, available <http://www.efdeportes.com/efd87/taek.htm>.

### RHABDOMYOLYSIS AFTER PERFORMING BLOOD-FLOW RESTRICTION TRAINING: A CASE REPORT

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Introduction: Low intensity blood-flow restriction (BFR) training is routinely performed in Japan. Numerous studies using BFR training have shown muscle hypertrophy to occur with a training intensity as low as 20% one repetition maximum (1RM) [Loenneke JP et al. 2012]. However, little is known about the most effective BFR training protocol regarding exercise intensity and occlusion pressure and occlusion duration [Pope ZK et al. 2013]. Although many complications such as subcutaneous hemorrhage or temporary numbness caused by BFR training have been reported [Gualano B et al. 2010], to our knowledge, there are only a few reports about serious complications after performing BFR training. This is the case of a patient presenting with severe rhabdomyolysis on the next day after performing BFR training. Case Description: The patient is a 30-year-old Japanese obese male who has no significant past medical history. He performed squats (3 sets of 20 reps) with his leg muscle BFR under the instruction of a trainer for the first time. No further information about exercise intensity or occlusion pressure was available. On the next day, he was admitted to our hospital with complaints of severe muscle pain of his upper and lower extremities, high fever and pharyngeal pain. He was diagnosed with acute rhabdomyolysis, with serum creatine phosphokinase (CPK) of 56,475 U/l and urine myoglobin of >3000 ng/ml, accompanied by acute tonsillitis, with a white blood cell of 7,390 and CRP of 10.43 mg/dl. Excessive muscular workout with BFR and bacterial infection was suspected to contribute to the onset of rhabdomyolysis. He was treated with rapid and aggressive infusion of intravenous fluids and antibacterial drug, and CPK decreased without presenting acute renal failure after having reached to up to 89,824 U/l on the 2nd hospital day. Discussion: It has been reported that there are secondary factors that can exacerbate exercise muscle damage such as dehydration, existing bacterial or viral infections, heat stress and nutritional supplement and drug use [Springer BL et al. 2003]. Our case shows that BFR training in an inappropriate way is at risk for leading serious complications such as rhabdomyolysis, especially when accompanied by deconditioning. References: Gualano B, Neves M Jr, Lima FR, Pinto AL, Laurentino G, Borges C, Baptista L, Artioli GG, Aoki MS, Moriscot A, Lancha AH Jr, Bonfá E, Ugrinowitsch C. (2010). *Med Sci Sports Exerc.* 42(2): 250-254. Loenneke JP, Wilson JM, Marin PJ, Zourdos MC, Bemben MG (2012). *Eur J Appl Physiol.* 112(5): 1849-59. Pope ZK1, Willardson JM, Schoenfeld BJ. (2013). *J Strength Cond Res.* 27(10): 2914-2926. Springer BL, Clarkson PM. (2003). *Med Sci Sports Exerc.* 35(9): 1499-1502. Contact: sky\_walker\_590718@yahoo.co.jp

### A NEW ASSESSMENT METHOD USING A COMBINATION OF JOINT KINETICS AND PERFORMANCE VARIABLES DURING THE REBOUND JUMP TEST

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Introduction In sprint running and ball sports, measuring the stretch-shortening cycle (SSC) performance of the lower leg is necessary. Drop jump and rebound jump (RJ) tests are mostly used to test SSC performance (Bobbert, 1990; Zushi et al., 1993), although performance variables, such as contact time, jumping height and rebound jump index (RJ index; Zushi et al., 1993), are also used, which result from interactions between the muscle groups and three lower limb joints. Thus, if a new measurement system is developed that measures and calculates the mechanical variables of the three lower limb joints (torque, power and work) in real time with the performance variables, athletes' SSC performance can be diagnosed with more accuracy and detail. This study proposed a new assessment method that combines joint kinetics and performance variables in the RJ test. Methods The RJ test was performed by 27 male jumpers. Three-dimensional coordinates of 12 retro-reflective markers fixed on each subject's body were collected using a Vicon T20 system operating at 250 Hz. Ground reaction forces were obtained with a force platform at 1000 Hz. The Quick Motion Analysis System, which automatically calculates and presents the above-mentioned data immediately after the RJ test, was jointly developed with DKH Inc. in Japan and used to measure joint torque, power and work of the three lower limb joints. Results and Discussion The correlation coefficient between IAAF scores (jump events performance used by the IAAF Scoring Tables of Athletics) and RJ index had a marginally significant, while a significantly positive correlation was noted between IAAF scores and jumping height. Thus, our findings indicate that jumpers' specialized muscle strength and power exertions can be evaluated by RJ test. We examined the correlation between IAAF score and mechanical variables of the three lower limb joints. Significant correlation coefficients were noted between IAAF score and negative ankle joint work and between IAAF score and positive hip joint work. Therefore, high-performance jumpers were characterized by a significantly large amount of work in the ankle and hip joints on the RJ test. We also examined the correlations between the functions of the three lower limb joints; for relative work (calculated as the ratio of work for each joint relative to the total sum of work for the three lower limb joints), significant negative correlation coefficients were found in the ankle and knee joints and in the ankle and hip joints. This showed a relationship in work between the three lower limb joints, but the work by the three lower limb joints are in a conflicting relationship. Thus, we used a new assessment system to evaluate torque, power, work and relative work that may be a useful tool for assessing muscle strength and power. References Bobbert MF. (1990). *Sports Medicine*, 9, 7-22. Zushi K, Takamatsu K, Koto, T. (1993). *Japan J Phys Educ Hlth Sport Sci*, 38, 265-278.

## THE ANALYSIS FOR THE RELATIONSHIP BETWEEN BONE FORMATION AND PHYSICAL AND PERFORMANCE CHARACTERISTICS OF JAPANESE COLLEGIATE AMERICAN FOOTBALL PLAYERS

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**Introduction** Although there have been many studies for athletes focusing on muscular strength and physical and/or performance characteristics (e.g., lean body mass), as far as we know, little studies have been conducted on the relationship between bone formation and those characteristics described above. One of the main reason why there has been a lack of such study is that there are the difficulties in measuring the index of bone (e.g., bone mineral density) such as exposure to radiation or time-consuming process, etc. In order to solve those problems, the LD-100 system (Oyo Electronics, Kyoto, Japan), which is a fast, non-invasive ultrasonic instrument using the ultrasonic parameters on the basis of fast and slow waves at the distal radius of non-dominant hand, has been newly developed. Thus, our aim of this study was to examine how the indexes of bone were related to the performances and physical characteristics of the collegiate American football players using a superior ultrasonic bone densitometry system. **Methods** Fifty-six collegiate American football players (age=20.5±1.2 years) were recruited for the current study. The subjects were divided into 2 groups according to their positions: skill positions, linemen. The LD-100 system was performed for each subject to obtain the parameters of bone: trabecular bone density (TBD, mg/cm<sup>3</sup>), the attenuation of waves (dB), radius thickness (mm), cortical thickness (CoTh, mm), elastic modulus of trabecular bone (EMTb, GPa) and modulus of section (mm<sup>3</sup>). As for physical and performance indexes of the subjects, we collected body weight (kg), height (cm), body fat (%), lean body mass (LBM, kg), bench press/squat /high clean (kg and relative to body weight), vertical jump height (cm) and power(kg · s<sup>-1</sup>). As the reference data, we referred to the data collected by Sai et al. (2010). **Results** We found that power and body fat were positively correlated with TBD for all ( $p < 0.05$ ). Regarding skill position players, high clean relative to body weight was negatively correlated with EMTb and squat was positively correlated with CoTh and TBD ( $p < 0.05$ ), although those parameters for linemen were not correlated. **Discussion** Although many previous studies have confirmed a positive relationship between muscular strength and bone density, we found that power was positively correlated with TBD. This may imply that Olympic lifting such as high clean emphasizing power is better than power lifting in order to increase bone density. Reference Sai et al. (2010). Osteoporos Int, 21(10), 1781-90. Contact Junta Iguchi: iguchi@kyotogakuen.ac.jp

## A COMPARISON OF MUSCLE FATIGUE BETWEEN MAXIMAL AND SUBMAXIMAL STRENGTH GAINS DURING THE BENCH PRESS IN MEN

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**Introduction** The bench press is one of the most popular exercises used in strength training for the upper body (Roland van den Tillaar & Gertjan Ettema, 2013). In the case of submaximal strength gain, the optimal number of repetitions to perform under same loading conditions to achieve certain training goals has not been established (Luis sanchez-medina & Juan jose Gonzalez-badillo, 2011). Moreover, the role of resistance training to maximal and submaximal to optimize strength and power gains is unclear (Izquierdo et al., 2006). The study aim was to investigate a comparison of muscle fatigue between maximal and submaximal strength gains during the bench press in men. It was hypothesized that maximal voluntary contraction (%MVC) would similar gains between maximal and submaximal strength gains during the bench press, but median frequency (MDF) would increase in maximal compared with submaximal exercise. **Methods** Employing a randomized, counterbalanced crossover design, 12 men were asked to perform maximal repetitions and submaximal repetitions (concentric: 1-s, eccentric: 1-s, 2-s/repetition) to failure with a load of 85% of 1RM for the bench press, with a 3-minute recovery between the sets (Sakamoto A. & Sinclair P. J., 2012; Baechle & Earle, 2008). Each subject was tested for the number of repetitions and sets, total work, and 1-RM in bench press. Surface EMG was recorded from the pectoralis major, deltoid anterior, and triceps brachii for maximal voluntary contraction (%MVC) and median frequency (MDF). **Results** The changes in number of repetitions and sets and total work were significantly higher ( $p < 0.05$ , respectively) in the submaximal repetitions as compared with the maximal repetitions performed during the bench press. The changes in %MVC were not significantly different between maximal and submaximal strength gains, but the changes in MDF were significantly smaller ( $p < 0.05$ , respectively) in the maximal repetitions as compared with the submaximal repetitions selected muscles during the bench press. **Discussion** Our study showed that a smaller muscle fatigue in submaximal repetitions, despite higher in total work and a similar in muscle activity were observed. It seems that these changes lead to the remarkable increased volume or intensity for improving maximum force and muscle power. References Roland van den Tillaar and Gertjan Ettema. (2013). Journal of Human Kinetics volume, 38, 63-71. Luis sanchez-medina & Juan jose Gonzalez-badillo. (2011). Med Sci Sports Exerc. 43(9), 1725-1734. Izquierdo M, Javier Ibanez, Juan Jose Gonzalez-Badillo, Keijo Hakkinen, Nicholas A. Ratamess, William J. Kraemer, Duncan N. French, Jesus Eslava, Aritz Altadill, Xabier Asiain, Esteban M. Gorostiaga. (2006). J Appl Physiol. 100: 1647-1656. Sakamoto A. & Sinclair P. J. (2012). Eur J Appl Physiol. 112: 1015-1025. Baechle, T.R. & Earle, R.W. (2008). Essentials of strength training and conditioning (3th ed.). Human Kinetics, Champaign. Contact [hoseh28@dankook.ac.kr]

## THE EFFECTS OF FIVE WEEKS OF HIGH-INTENSITY INTERVAL TRAINING ON PHYSIOLOGICAL INDICES IN FEMALE FUTSAL PLAYERS: A COMPARISON BETWEEN TWO MODELS

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**Introduction** The purpose of this study was to compare the effects of two models of the high-intensity interval training (HIIT) performed during five weeks, on physiological indices in elite futsal players. **Methods** Sixteen female futsal players (divided in two groups) performed the Futsal Intermittent Endurance Test (FIET) to determine the peak velocity (PVFIET). The laboratory tests were performed on a motorized treadmill and consisted of a submaximal protocol to obtain the running economy (RE). And an incremental test was performed to determine the maximum oxygen consumption (VO<sub>2</sub>max), peak velocity (PVTR) and velocity at lactate threshold (vLT). The training models (implemented twice a week during five weeks) were designed from shuttle running intervals and consisted of four sets of 4-minute bouts with 4-minutes of rest intervals between sets. The main difference between the two models was the timing of the intervals, one being performed by 7.5s of running and 7.5s of resting (HIIT7.5x7.5), and the other by 15s of running and 15s of resting (HIIT15x15). In the HIIT7.5x7.5 model, the athletes performed 17x7.5s shuttle runs (with a direction change every 3.75s) and the HIIT15x15 model consisted of 9x15s (with a direction change every 3.75s). The intensity used for the HIIT7.5x7.5 was 86-91 %PVFIET and for the HIIT15x15 was 83-88 %PVFIET. The ANOVA mixed model with post hoc Bonferroni was used for comparing ( $p \leq 0.05$ ). The effect size (ES) was also calculated to

analyze the magnitude of the improvements. Results The PVFIET increased significantly from  $14.7 \pm 0.8$  to  $15.7 \pm 0.7$  km/h for HIIT7.5x7.5 (ES=1.58) and from  $14.9 \pm 1.0$  to  $16.1 \pm 1.2$  km/h for HIIT15x15 (ES=1.2). The PVTR increased from  $14.0 \pm 1.2$  to  $14.4 \pm 0.8$  km/h for HIIT7.5x7.5 ( $p=0.05$ ; ES=0.9) and from  $13.6 \pm 1.5$  to  $14.5 \pm 1.3$  km/h for HIIT15x15 ( $p \leq 0.01$ ; ES=1.9). The vLT was enhanced from  $10.1 \pm 0.6$  to  $11.6 \pm 0.7$  km/h for HIIT7.5x7.5 (ES=3.2) and from  $10.0 \pm 0.5$  to  $11.5 \pm 1.0$  km/h for HIIT15x15 (ES=2.1). The RE showed no significant improvement for both models, but showed an ES= 0.7 for HIIT15x15. Discussion The present study used two models of HIIT performed in shuttle running derived from FIET. The main hypothesis was that the model with more changes of direction (i.e. HIIT15x15) could trigger greater improvements in aerobic fitness. In conclusion, the completion of 10 training sessions in both HIIT models elicits similar improvements in aerobic fitness in female futsal athletes. References Almarwaey OA, Jones AM, Tolfrey K. (2003). *Med Sci Sports, Exerc*, 35, 480-487. Helgerud J, Engen LC, Wisloff U, Hoff J. (2001). *Med Sci Sports, Exerc*. 33(11), 1925-1931. Contact luiz.guilherme@ufsc.br

### **A STUDY TO ASSESS THE EFFECT OF THE PREVENT INJURY, ENHANCE PERFORMANCE PROGRAMME ON LOWER EXTREMITY INJURY INCIDENCE AND NEUROMUSCULAR FUNCTIONAL OUTCOMES IN GAELIC GAMES**

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Introduction: Gaelic football and hurling are two highly popular field games in Ireland. A study conducted across inter county GAA football teams over 4 consecutive seasons revealed that 76% of the injuries recorded were lower extremity injuries, which suggests that lower extremity injuries predominate in the body(1). These injuries can have player, team and institutional impacts and may be resultant of the physical demands of the games. Murphy et al (2012) have shown it is possible to record injury data consistently with the GAA and stated that quantifying the incidence of injury is the first step of injury prevention. The goals of the PEP, as developed by Mandelbaum(2), were to avoid vulnerable positions, enhance flexibility, enhance strength, optimise plyometrics and address proprioception and sport specific agilities. Results showed there was a 74% reduction in ACL injuries after 2 years. No such injury prevention techniques have been researched and published by the GAA to date, therefore this study will investigate the effects of the PEP on injury incidence in Gaelic games. Methodology: Over 140 male players were recruited from the GAA teams of the Institutes of Technology Carlow (ITC) and Waterford (WIT). Pre-testing (at the start of the season) and post-testing (at the end of the season) involved two objective screening tests to assess pre and post intervention neuromuscular function. Practical workshops, with ongoing liaison, were executed with coaches and trainers involved with ITC and WIT on the implementation of the programme. A traditional PEP was created for WIT and a dynamic PEP for ITC. The existing GAA database was accessed and utilised to monitor player injuries. Semi-structured interviews with involved health care professionals, coaches and the players were conducted to gain an insight into the practicalities of the programme. Results: It is envisaged that this study will show the effects of the PEP on lower extremity injury incidence and neuromuscular function. The semi-structured interviews will provide insights into the practicalities of a structured warm up. Preliminary results are expected in April 2015. Discussion: The findings of this study will contribute to the continued development of the best practice guidelines in lower extremity injury prevention in the GAA. References: 1.Mandelbaum,B. Silvers,H. Watanabe,D. Knarr,J. Thomas,S. Griffin,L. Kirkendell,D. Garrett,W.(2005). Effectiveness of a Neuromuscular Proprioceptive Training Program in Preventing the Incidence of ACL Injuries in Female Athletes. *Am J Sports Med*.33 (7),p1-8. 2.Murphy,J. O'Malley,E. Gissane,C. and Blake,C.(2012). Incidence of Injury in Gaelic Football:A 4-Year Prospective Study. *Am J Sports Med*.40(9),p2113-2120.

### **TEST-RETEST RELIABILITY OF THE WINGATE 6 AND 30 SECOND TESTS IN MALES AND FEMALES**

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Introduction To accurately quantify the influence of an intervention, it is important to know the typical variance in test performance. Current data on the performance reliability of cycle sprinting suggests that reliability data from one sprint duration should not be applied to sprints of different durations, and that reliability data generated from males should not be applied to females. However, the performance reliability of the same group of males and females performing the 6 and 30 sec Wingate anaerobic tests has not been evaluated. This study assessed the performance reliability of the 6 and 30 sec Wingate tests in males and females. Methods Participants completed four trials each comprising of a single 6 sec cycle sprint against 7.5% body mass resistance, a 15 min seated recovery, and a single 30 sec cycle sprint against the same resistance. Peak power output (PPO) and mean power output (MPO) were calculated for each sprint. Participants consumed a light meal at least 2 h before testing, and refrained from strenuous exercise for at least 24 h before each trial. Within-participants, trials were completed at the same time of day. Results For both sprints, there was no significant difference in PPO or MPO between any pairs of trials for either gender. For males, PPO in both sprints demonstrated ICCs  $\geq 0.91$  and CVs  $\leq 3.9\%$  in all between-trials pairwise comparisons. For MPO, ICCs  $\geq 0.89$  and CVs  $\leq 2.9\%$  were found in all comparisons. For females, PPO demonstrated ICCs  $\geq 0.87$  and CVs  $\leq 6.5\%$  in all comparisons. Random variation in MPO in the 6 sec sprints fluctuated between comparisons. For the 30 sec sprint, MPO was more stable, with ICCs  $\geq 0.93$  and CVs  $\leq 5.0\%$  in all comparisons. Females improved PPO reliability across the trials for both sprints, whereas males were more consistent across trials. Females showed more variability in 6 sec MPO compared to males, but both genders produced consistent 30 sec MPO. Discussion The consistent PPO and MPO of the males in both sprints conflicts with previous research suggesting the requirement for at least one familiarisation trial (Barfield et al., 2002; Mendez-Villanueva et al., 2007). The progressive improvement in reliability for 6 and 30 sec PPO in females indicates that at least one familiarisation trial may be required, supporting the suggestion that females are less reliable than males (Hopkins et al., 2001). The greater reliability of females in the 30 sec vs. 6 sec sprint may reflect the greater number of pedal revolutions cancelling out fluctuations in force and cadence in individual revolutions (Hopkins et al., 2001). References Barfield et al. (2002) *J Strength Cond Res*, 16, 472-473. Hopkins et al. (2001) *Sports Med*, 31, 211-234. Mendez-Villanueva et al. (2007) *J Sci Med Sport*, 10, 323-326. Contact shaun.phillips@ed.ac.uk

### **SMALL-SIDED GAMES AND THE ASSESSMENT OF INTERNAL LOAD IN YOUNG SOCCER PLAYERS**

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Introduction Small-sided games (SSG) are football training drills in the form of games played in a reduced space, involving fewer players and a shorter playing time. Many studies have analysed the different types of SSG in soccer training (Halouani et al., 2014); however, until now, no research has monitored the internal load (% max. heart rate [%HRmax] and % mean heart rate [%HRmean]) resulting from the 3vs3 format played in the "cage" mode, a training drill devised by a professional Italian football coach in 1991. The "cage" consists of a

playing areas delimited along its perimeters and above the pitch by a metal grid that prevents the ball from exiting the pitch and the game from stopping. The present study aims to evaluate and compare the cardiac responses recorded in players during 3vs3G and 8vs8G; and to investigate the correlation between VO<sub>2</sub>max and HR recorded during the different phases of a 3vs3G and at rest. Methods VO<sub>2</sub>max was assessed in 16 young soccer players (m±sd: age:13±0.1 years, height 155.5±8.6 cm, weight 45.4±10.1 kg) using the Leger test (Léger and Bocher, 1980) 72h after a 8x8G (2x25', 5' rest) and 72h after a 3x3G (4x3', 2' rest). HR was monitored during the SSG using a heart rate telemetry system (Polar, Kempele, Finland). Results The mean VO<sub>2</sub>max for the study group was 54.23±3.89 ml/kg/min. For the 3vs3G vs. 8x8G comparisons, %HRmean and %HRmax were: 88±2.7 vs. 77±3.8% and 94.6±1.5 vs. 88.6±2.9%, respectively. Both differences were significant (p<0.0005). A significant correlation emerged between the values of VO<sub>2</sub>max and HR recorded during the first (r=-0.843, N=16, p<0.01) and second minute of recovery (r=-0.579, N=16, p<0.05) in the first series, and in the first minute (r=-0.680, N=16, p<0.05) of the second series. Discussion The HR values recorded during the two SSG formats are coherent with those of other studies showing that higher performance intensity is associated with formats involving fewer players (Rampinini et al.,2007). The indirect correlations between the values of VO<sub>2</sub>max and HR during the recovery phases lead us to hypothesise that even young soccer players with higher levels of VO<sub>2</sub>max are able to recover better after intense exercise, as indicated in the literature (Borresen and Lambert, 2008). References Borresen J, Lambert MI. (2007). *Eur J Appl Physiol*, 101:503-511. Halouani J, Chitourou H, Gabbett T, Chaouachi A, Chamari K. (2014). *J Strength Cond Res*, 28(12):3594-3618. Léger L, Boucher R. (1980). *Canadian J Appl Sport Sci*, 5:77-84 Rampinini E, Impellizzeri FM, Castagna C, Abt GA, Chamari K, Sassi A, Marcora M. (2007). *J Sports Sci*, 25(6):659-666.

## PHYSICAL STRENGTH AND MOTOR SKILLS CHANGE IN PARENTS AND CHILDREN PHYSICAL EXERCISE PROGRAM

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Introduction In recent years, declines in physical strength and athletic ability of children have become a social issue. To improve the physical fitness, parents and children should work together in young youth and make it as custom. This study aimed to examine the effect of 12-weeks physical activity program comprised class and home-based both once a week. Methods Participants are kindergartners from 4 to 6 years old and their parents. The subjects installed the intervention group (n=20 both children and parents) and the control group (n=30 both children and parents). The measuring evaluation items were Bone density, Ground reaction force, Reaction time, Functional reach test, Stepping test (10sec), Standing jump test, Catching the ball test and Throwing the ball test. We collected and analyzed data from participants who completed pre-and post-tests. Results There were significant group x time interaction of Reaction time and Stepping test (10sec) by the parents. Significant time effects were observed in the following tests: Stepping test (10sec) and Catching the ball test. Conclusion These results suggest the effect of parents and children physical exercises may be slightly enhanced by intervention with agility of parents and motor skill of children. References Epstein, Leonard H., Wing, Rena R., Koeske, Randi., Valoski, Alice(1984)Effects of diet plus exercise on weight change in parents and children. *Journal of Consulting and Clinical Psychology*, 52(3), 429-437. Contact nadamoto@poole.ac.jp

## INFLUENCE OF TRAINING LEVEL ON NOCTURNAL HEART RATE VARIABILITY OF HEALTHY YOUNG STUDENTS

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For athletes who repeat intense training, it is extremely important to retain the function of parasympathetic nerves, to take good rest and to recover well. Purpose: Main purpose of this study was to examine the suitable indices of Heart rate variability (HRV) to prevent over-training and to evaluate athlete's daily condition. We also examine the autonomic function in healthy students with and without a habit of physical training. Methods: The Autonomic Nervous activity entering the heart was analyzed in following conditions. 1)HRV for 5 minutes direct after awaking was measured in long-distance runners at different training periods. 2)Nocturnal HRV was measured in 4 Lacrosse players at different training periods. In addition, 10 healthy students without a habit of physical training were also participated in this experiment. In both 1) 2), Polar analysis program was used to calculate the the heart beat fluctuation. 3)Nocturnal HRV of 2 male soccer players were repeatedly measured 10 times/year at different training sessions using Acti HR4. Results and Conclusion: Having exercise custom or not did not bring significant difference to sleeping parasympathetic nerve activity of young healthy students. HR and HRV Indices, such as %HF, SD1 (= Cross sectional distribution of R-R scatter diagram), reflected athlete's mental and physical condition during stressful training period to some extent. But further research is needed to establish a theory and methodology.

## CHANGING THE PARAMETERS OF VARIABILITY OF THE CARDIORESPIRATORY SYSTEM UNDER THE INFLUENCE OF THE TRAINING LOAD

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Introduction The adequacy of physical activity in terms of the training process often associated with the assessment of the response of heart rate and metabolic parameters with the calculation of individual indicators oxygen provided in response to exercise. At the same time, other informative criteria associated with the use of instrumental methods are rarely used because of the impossibility of their use in the process of training. Methods To solve this problem, we used express, noninvasive method spiroarteriocardiorhythmography (SACR), which allows simultaneous recording of ECG parameters in I leads, systolic and diastolic blood pressure (photo plethysmographic method) for each heartbeat and spirography and calculating indices of heart rate variability (HRV) systolic (SBPV) and diastolic (DBPV) blood pressure variability and spontaneous breathing variability (SBV) according to two-minute registrations. In previous studies, when examining qualified athletes we have obtained centile distribution of HRV, SBPV, DBPV and SB dormant within 0-5%, 5-25%, 25-75%, 75-95% and 95-100%, which are valued as a marked reduction, moderate decrease, the normal, a moderate increase and pronounced increase in, respectively (Romanchuk A.P.,2014). Results Were examined 32 qualified male athlete involved in water polo at the age of 20,6 ± 3,0 years. The study was conducted using Sacra before and during the first 5 minutes after your workout. It is shown that under the influence of the training load HRV significantly reduced - there is marked reduction of TP (ms2) in 54.8% of cases, VLF (ms2) in 29% of cases, LF (ms2) in 25.8% of cases, HF (ms2) 58%, and a moderate decrease TP (ms2) in 25.8% of cases, VLF (ms2) in 41.9% of cases, LF (ms2) in 32.3% of cases. The ratio of LF/HF is increased moderately in 48.4% of cases. Indicators SBPV and DBPV tend to increase - moderately and pronounced increase TSBP (mm hg.2) and TRDBP (mm hg.2) in 42.0% of cases each, VLF5BP (mm hg.2) in 61.3% of cases, LFSBP (mm hg.2) in 45.2% of cases, the ratio LF/HFDBP in 64.5% of cases. HFDBP (mm hg.2) moderately and pronounced decreases in 48.4% of

cases. Insignificantly changed under the influence of physical activity VLFDBP (mm hg.2), LFDBP (mm hg.2), HFSBP (mm hg.2). Characteristic changes were indicators SB - moderate increase and pronounced increase in TPSB (l/min2) in 71.0% of cases, VLFSB (l / min2) and LFSB (l / min2) in 48.4% of cases, HFSB (l / min2) in 61.3% of cases. Discussion Noteworthy changes dissociation indicators and VLFSBP, VLFDBP, LFSBP and LFDBP, HFSBP and HFDBP that can be used as the basis of differentiation level of functional state of cardiorespiratory system of athletes in the training process. References Romanchuk, AP. (2014) The Complex Approach to a Multipurpose Estimation of a Sportsmen Condition In: Polysystemic Approach to School, Sport and Environment Medicine, M. Karganov ed., OMICS Group eBooks, 731 Gull Ave, Foster City, CA 94404, USA, 160 p. Contact doclfc@ua.fm

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