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THE IMPACT OF STRENGTH AND COORDINATION ON THE SUCCESS OF PERFORMANCE OF THE FREESTYLE SWIMMING

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Abstract:
The aim of this study is to determine the influence of motor skills (repetitive strength and coordination) on the success of performance freestyle swimming before and after the completed swimming training program. The research was conducted on a sample of 90 students, both male and female, aged 11-12, the fifth grade of primary school students from Novi Grad municipality in Sarajevo, with 6 motor variables and 1 criterion variable. A regression analysis was used to determine the effects of repetitive power and coordination on the performance of freestyle swimming. By analyzing the presented results of the regression analysis it can be concluded that after the initial measurement of the variables for the repetitive power estimation, the most important and statistically significant influence on the criterion variable OCJTEH had the following predictor motor variables: MRSDTZ (BETA) = 0.217, which is significant at p = 0.033, MRSSKL (BETA) = 0.285, which is significant at p = 0.007, MRSDCU (BETA) = 0.383 which is significant at p = 0.000, and in coordination the following predictor motor variables: MKOPRP (BETA) = 0.393, which is significant at p = 0.001, MKOPRL (BETA) = 0.198, which is significant at p = 0.049, MKOOUZ (BETA) = 0.268 which is significant at = 0.004. After the final measurement of the variables for the assessment of motor

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abilities (repetitive forces and coordination) the most significant influence on the OCJTEH criterion variable (swimming for 25 m free technique) had the same variables as in initial measurement: at repetitive force variables – MRSDTZ, MRSSKL, MRSDCU, in co-ordination variables – MKOPRP, MKOPRL, MKOOUZ.

Keywords: students, motor skills, influence, swimming

1. Introduction

Rađo (1998), in his research, comes to the conclusion that swim successes is mostly contributed to variables of co-ordination, explosive and repetitive strength, speed and flexibility as well as speed of nerve-muscle reaction in vision. Mirvić, & Rašidagić, (2002), conducted a research on a population of 50 participants of the sports camp Vela Luka on Korcula, aged 7-15 years. Children were involved in the training processes of various sports, but without elementary swimming knowledge, as established by initial testing. The control and experimental group also numbered 25 respondents with evenly represented ages in both groups. As the only control variable, the length of the swimmed distance is expressed in metric. On the basis of the results obtained within this research, they found that there are no statistically significant differences in the implementation of swimming program between groups, regardless of the chosen approach.

Madić, Okačić, & Aleksandrović, (2007) state that the overall anthropological status, such as morphological characteristics, functional, psychological, biomotor and intellectual abilities, affects the performance of swimming techniques. Torlaković, (2009), explored the effects of an experimental training program for non-swimmers on the dynamics of learning elemental swimming elements in boys ages 8 to 10 years. The results of the research have shown that boys who are engaged in leisure with some sport can adopt basic swimming elements faster and more efficiently. In support of this he says that athletes probably have a more pronounced need for achievements, perception and motor skills, as well as greater motivation for success. Torlaković, (2009), on a sample of 88 younger school children, explored the effects of intensive training of the basic swimming elements created under the influence of programmed work within extracurricular activities. An intensive 12-hour training program proved to be efficient because the obtained parameters determined a statistically significant positive change for all variables as a result of the applied training program. In order to be able to speak about the significance of motor skills, these children, to their result of performance in some kinesiological activity, in this case swimming (free style), it is necessary first to know the basic structures of movement in a given activity, basic characteristics of individual motor skills and their mutual influence. Swimming as a sport or in general as a moving activity that a man realizes is specific to the fact that it takes place in a water environment that possesses certain physical characteristics that greatly affect the character of man's movements, and thus also the realization of his

motor skills. In such conditions, the child must adapt, so that their motor skills are at the highest possible level to achieve the best results possible and to learn how to swim as soon as possible. Working with children at this age is quite responsible because the general development of the child is still not finished, and therefore because of the fact that they are beginners, and that trainers' commitment is greater.

The aim of this research is to determine the magnitude of the influence of motor skills (repetitive strength and coordination) on the performance of the freestyle swimming before and after the completed swimming training program.

2. Methods

A sample of 90 pupils, both sexes, aged 11-12, of the fifth grade of elementary schools from Novi Grad Municipality in Sarajevo. All of the students were measured with 6 variables imagined to cover certain motor skills (repetitive strength and coordination) and one criterion variable. The selection of measuring instruments was carried out on the basis of standards, recommendations, and numerous literature in order to obtain maximum useful information about the occurrences in children from the measured results. For the assessment of the motor abilities of the respondents, 6 variables were designed to cover the space of the primary motor dimensions: repetitive force variables (push-ups MRSSKL, deep squats – MRSDCU, sit-ups(from lying position) – MRSDTZ); co-ordination variables (air rotation – MKOOUZ, throwing a ball from hand to hand over head for 30 seconds – MKOPRL, co-ordination with a stick-MKOPRP) and 1 criterion variable for assessing the performance of freestyle swimming, technique rating – OCJTEH (Swimming for 25 m freestyle). The work program carried out in this research is based on the principles of theory and practice that treats the method of work with beginners. The core program covered the activity through: time period: (four months, with respondents being divided into two groups of 45 pupils in two months per group), number of training units: 16 classes per group (2 times per week), duration of one class: 90 minutes, with the aim of determining the influence of motor skills (repetitive power and coordination) on the performance of freestyle swimming before and after the swim training program.

Table 1: Assessment criteria

A Mark:	The Level of Mastered Technique:
1 (mark E)	Absolute non-swimmer.
2 (mark D)	Floater. There are major mistakes in performing coordination elements of crawl technique and complete absence of breathing technique.
3 (mark C)	Half-swimmer. There are obvious mistakes in performing some coordination elements of crawl technique, and some mistakes in breathing technique.
4 (mark B)	Satisfying performance of crawl technique, with insignificant mistakes in hand and leg coordination.
5 (mark A)	Techniques which are carried out with the optimal angle of attack (crawl), by a proper coordination and breathing.

Table 2: Initial measurements

Initial measurement		
Marks	**Total**	**Percentage**
1-E	41	46%
2-D	24	27%
3-C	24	27%
4-B	1	0%
5-A	0	0%
Total number: 90		
Percentage of swimmers: 27%		
Percentage of non-swimmers: 73%		

Table 2.1: Final measurements

Final measurement		
Marks	**Total**	**Percentage**
1-E	0	0%
2-D	25	28%
3-C	31	34%
4-B	25	28%
5-A	9	10%
Total number: 90		
Percentage of swimmers: 72%		
Percentage of non-swimmers:: 28%		

From the above tables (Table 2.1 and 2.2), it can be seen that, according to the initial measurement before the implementation of the training program, the percentage of non-swimmers was 73% and the percentage of swimmers was only 27%, whereas according to the final measurement after the training program the percentage of non-swimmers was 28%, and the percentage of swimmers is surprising 72%. It should be emphasized that the percentage of non-swimmers, according to the final measurement, cover students who fall into the category of floaters, while no one has received the 1-E rating, i.e. remained a complete non-swimmer. Data obtained in this study were processed using SPSS 16.0 software packages. The regression analysis was applied to determine the effects of motor skills (repetitive strength and coordination) on the performance of freestyle swimming before and after the completed swimming training program.

3. Results

The regression analysis is applied to determine the influence of motor abilities (repetitive power and coordination), designated as an input or predictor set, on success in swimming, designated as output or criterion variables. Based on the size of multiple regression (R), a common variant (R Square) is explained only if it is statistically significant.

3.1. Variables for Assessing Motor Abilities (Initial Measurement)

3.1.1. Variables for Assessment of Repetitive Power

Table 3.1: The value of multiple correlation coefficients between prediction variables and criterion

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	,789[a]	,623	,610	,41300
a. Predictors: (Constant), MRSDCU, MRSDTZ, MRSSKL				

Table 3.2: Variables and level of significance of F ration in the question of differences between subgroup results along the path of regression

ANOVA[b]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	**Regression**	24,231	3	8,077	47,354	,000[a]
	Residual	14,669	86	,171		
	Total	38,900	89			
a. Predictors: (Constant), MRSDCU, MRSDTZ, MRSSKL						
b. Dependent Variable: OCJTEH						

A high coefficient of multiple correlation R = 0.789 indicates a significant statistical effect of the variables for estimating repetitive power on the criterion.

Table 3.3: The value and level of significance of standardized and non-standardized regression coefficients for individual predictor variables

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	MRSDTZ	,034	,016	,217	2,165	,033*
	MRSSKL	,039	,014	,285	2,772	,007**
	MRSDCU	,063	,016	,383	3,954	,000**
a. Dependent Variable: OCJTEH						

The most important and statistically significant influence on the OCJTEH criterion have the following predictor motor variables: MRSDTZ (BETA) = 0.217, which is significant at p = 0.033, MRSSKL (BETA) = 0.285, which is significant at p = 0.007, MRSDCU (BETA) = 0.383 which is significant at p = 0.000

3.1.2 Variables for Assessment of Coordination

Table 4.1: The value of multiple correlation coefficients between predictive variables and criterion

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	,735[a]	,540	,524	,45607
a. Predictors: (Constant), MKOOUZ, MKOPRL, MKOPRP				

Table 4.2: Value and level of significance F ratio in question of difference between the subgroup of results along the regression path

ANOVA[b]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	**Regression**	21,012	3	7,004	33,674	,000[a]
	Residual	17,888	86	,208		
	Total	38,900	89			

a. Predictors: (Constant), MKOOUZ, MKOPRL, MKOPRP
b. Dependent Variable: OCJTEH

The high coefficient of multiple correlation R = 0.735 indicates a significant statistical effect of variables for estimating coordination on the criterion.

Table 4.3: The value and level of significance of standardized and non-standardized regression coefficients for individual predictor variables

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	MKOPRP	,055	,015	,393	3,580	,001**
	MKOPRL	,027	,013	,198	1,998	,049*
	MKOOUZ	,038	,013	,268	2,963	,004**

a. Dependent Variable: OCJTEH

The most important and statistically significant influence on the OCJTEH criterion variable have the following predictor motor variables: MKOPRP (BETA) = 0.393, which is significant at p = 0.001, MKOPRL (BETA) = 0.198, which is significant at p = 0.049, MKOOUZ (BETA) = 0.268 which is significant at p = 0.004.

3.2 Variables for Assessing Motor Abilities (Final-End Measurement)

3.2.1 Variables for Assessment of repetitive power

Table 5.1: The value of multiple correlation coefficients between predictive variables and criterion

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	,837[a]	,701	,690	,53096

a. Predictors: (Constant), MRSDCU, MRSDTZ, MRSSKL

Table 5.2: Value and level of significance F ratio in question of difference between the subgroup of results along the regression path

ANOVA[b]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	**Regression**	56,744	3	18,915	67,094	,000[a]
	Residual	24,245	86	,282		
	Total	80,989	89			

a. Predictors: (Constant), MRSDCU, MRSDTZ, MRSSKL
b. Dependent Variable: OCJTEH

The high coefficient of multiple correlation R = 0.837 indicates the significant statistical effect of the variables for the repetitive power rating on the criterion.

Table 5.3: The value and level of significance of standardized and non-standardized regression coefficients for individual predictor variables

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	MRSDTZ	,007	,003	,137	2,262	,026*
	MRSSKL	,046	,011	,283	4,096	,000**
	MRSDCU	,136	,016	,612	8,639	,000**
a. Dependent Variable: OCJTEH						

The most important and statistically significant influence on the OCJTEH criterion variable have the following predictor motor variables: MRSDTZ (BETA) = 0.137, which is significant at p = 0.026, MRSSKL (BETA) = 0.283, which is significant at p = 0.000, MRSDCU (BETA) = 0.612 which is significant at p = 0.000

3.2.2 Variables for Assessment of Coordination

Table 6.1: The value of multiple correlation coefficients between predictive variables and criterion

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	,894[a]	,800	,793	,43396
a. Predictors: (Constant), MKOOUZ, MKOPRL, MKOPRP				

Table 6.2: Value and level of significance F ratio in question of difference between the subgroup of results along the regression path

ANOVA[b]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	**Regression**	64,793	3	21,598	114,688	,000[a]
	Residual	16,195	86	,188		
	Total	80,989	89			
a. Predictors: (Constant), MKOOUZ, MKOPRL, MKOPRP						
b. Dependent Variable: OCJTEH						

The high coefficient of multiple correlation R = 0.894 points to the significant statistical influence of variables for estimating coordination on the criterion.

The most important and statistically significant influence on the criterion variable OCJTEH have the following predictor motor variables: MKOPRP (BETA) = 0.498, which is significant at p = 0.000, MKOPRL (BETA) = 0.244, which is significant at p = 0.001, MKOOUZ (BETA) = 0.253 which is significant at p = 0.000

Table 6.3: The value and level of significance of standardized and non-standardized regression coefficients for individual predictor variables

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	MKOPRP	,096	,016	,498	6,035	,000**
	MKOPRL	,046	,014	,244	3,285	,001**
	MKOOUZ	,051	,013	,253	3,798	,000**
a. Dependent Variable: OCJTEH						

4. Discussion

To perform any of the swimming techniques (free style swimming), flexibility and coordination are very important. When performing crawl techniques, a standard co-ordinate ratio of 1: 6 to 1 arm cycle (3 leg paddle movements) and 2 arm cycles (3 leg paddle movements) are present, and all this requires good flexibility. For the technique of the back crawl, the co-ordinate ratio is 1: 6, at 1 cycle of the arm movement, followed by 6 leg paddle movements. For co-ordination in sprinting swimming styles, the impression is that the arms and legs do not have anything to do with each other and work separately, each for themselves. Basically this is not true. At high speeds, preparatory phases floating in the hand movement and sliding in the work of the leg are reduced, while the propulsion phases remain rather constant. Dolphin style co-ordination - the ratio between the upper and lower extremities is 1: 2, at one arm cycle. Swimmers perform two leg paddles in a time interval of 1.2 to 1.4 seconds. It is easy to calculate that one simultaneous leg paddle lasts 0.6 to 0.7 seconds. The breathing technique is adapted and harmonized with the work of the hand. When the hand is drawn out of the water begins the breath that ends when the arms reach the shoulder height, followed by a pause, followed by a forged and a strong exhale in the pulling phase. For a successful overcoming of one of the swimming techniques (freestyle), continuous work (well-developed flexibility) and proper coordination of the arms and legs movement, plus breathing (Kazazović, 2008) are indispensable.

Kazazović, & Hadžikadunić, (1986), give an appraisal of the results of the crawl swimming technique on the 50, 100 and 200 m connections. A 25-test battery of motor abilities was used. With a single factor analysis, it has been found that flexibility contributes most to results in crawl technique 30.3%, static power 15%, explosive power 10.83%, repetitive power 9.64%, and speed of simple movements 6.5% (Kazazovic, 1990). Kazazović, (1984), explains the canonical relationships of motor and swimming. The results obtained in some way come under collapse with the assumption that short sprint disciplines are realized by aspects of explosive and repetitive forces. This has prompted the author to ascertain that the respondents have not developed good swimming technique, the seductive feelings of propulsion of a paddle, and their swimming results are achieved using unnecessary static strain of the whole body. That the strength with adequate mobility helps to achieve good results in swimming is

shown by a high value of the second factor of canonical correlation coefficient which was 0.654. The research has revealed that there is a stronger connection in the direction of motor skill - swimming (rather than reverse). In his doctoral dissertation, Volcanšek (1999) examines the influence of anthropometric and motor dimensions on the results of swimming. On a sample of 188 respondents in Zagreb, by canonical correlation analysis, the author gains one dimension between anthropometry and swimming, and two pairs of canonical dimensions between the motor sub-space and the swimming results. The first couple talks about swimming successes in those who possess: coordination ability, flexibility in the shoulder, successful handling of new motor tasks and speed of movement. The second canonical factor defines explosive power, agility and repetitive power, and projection on it has only the technique of chest swimming. Kapus, (1982) investigated the relationship between the variables of the basic and the situational swim motor skill using canonical analysis, on swimmers aged 10 to 12 years. Of the four distinguished canonical factors, the most interesting is the first one the author named the motor type of a successful swimmer. For this factor there is a significant motor structure determined by explosive power, where it is necessary to establish the initial inertia of body mass (Redžić, 2001).

Kazazović (1984), in a population of 115 male respondents, attempts to determine the relationship between all swimming techniques (nine variables) and 25 motor tests (represented by force factors, flexibility and speed of simple movements). Due to the canonical correlation analysis, two pairs of canonical dimensions were isolated. In the definition of the first pair, all force variables (primarily static), flexibility and long-distance swimming (100, 200 m) were involved. The other pair designed 12 motor variables (no speed of simple movements) and completely all swim variables. Regression correlation analysis, with probability of $p = 0.05$, was able to successfully predict the results on 100 m back, 50 m dolphin and 100 m mixed swimming technique. Rađo, Pivač, & Wolf, (1995), on a sample of 87 respondents, analyzed the influence of basic motor skills in the process of learning and building swimming techniques (crawl, back crawl, and breaststroke swimming).

Based on the regression analysis for successful learning of crawl and back crawl, good coordination, speed, as well as the flexibility of the shoulders and the feet in dorsal and plantar flexion are necessary. In the chest technique, of the applied predictive set of basic motor skills, only the dimensions of flexibility have significantly influenced the definition of the criterion variable (Rađo, 1998). Rađo, (1998), in a sample of 109 male respondents, concludes that in the function of success in swimming the most contributing factors are co-ordination, explosive and repetitive power, speed and flexibility as well as speed of nerve-muscular reaction in vision.

Vidović, (2000), in his dissertation included a survey on a sample of 181 male subjects. The measurements were performed using 16 morphological and 21 variables for the assessment of general motor abilities and 23 variables for the assessment of stylized forms of motion in the water (specific motor abilities). The results of the regression analysis of swimming with different techniques at 50 m provided sufficient

information on the impact of the predictive system on the variation of swimming success. In the space of motor skills, six dimensions are isolated: repetitive hull strength, explosive power, flexibility, movement frequency, coordination and general muscular endurance (Turković, 2001).

Redžić, (2004), on a sample of 35 male subjects, conducted a study on the relation between general and situational motor in anthropological space, which is significant to the results of swimming in a crawl technique. Five variables of the general motor skills used in the co-ordination area essential for crawl technique and four variables from the situational motor space were applied in the research. Using the regression analysis, it was attempted to determine the size of the general influence of the predictive system, which is presented by the general motor on the criterion system that represents the situational motor. At the time of swimming using crawl technique at 50 m, researched basic motor variables influenced in 20% of the explained results, while the other 80% in the explanation were influenced by other variables: general motor skills, anthropometry (Solaković, 2007).

Torlaković, (2009), in his research showed that boys who have already trained in some of the above sports more effectively adopted the basic elements of swimming, compared to children who are either not or have never been in the sport before. This indicates that motor skills are very important for swimming, because students that train some sports have better developed motor skills and thus achieve better success in swimming, which at the end of this research has been confirmed. In this study, students who were not active athletes showed weaker results. After the initial assessment of swimming level knowledge, 47 students received grade 1, which is 95.92%. On the seventh, eighth and ninth hour, the number of students with grades 3 and 2 increased. With the increase in the number of training hours, the students had better mastered the basic elements of swimming and more and more students had moved from swim to swimming. The pupils received higher and higher grades, and mark 5 was obtained on the fourteenth class by two students (4.08%). Regardless of this kind of progress, the largest number of students received a grade 1 (29 of them), which is 59.18% in percent. Gradually, the students got better grades, and by doing so, they gained better knowledge of swimming.

Thus in the final test, grade 1 was obtained by 7 students, which is a great success considering the number of non-swimmers after initial measurement. Most of the students in the final measurement swam the crawl technique with proper work of arms, legs and breathing, which was to be expected as the respondents were boys. The reason why these students did not learn to swim is likely to be that some students need more time to adapt to the aquatic environment and start swimming, as well as their physical inactivity and therefore less developed motor skills, which was confirmed by a research where students who have trained some sport were more successful in mastering some of the basic swimming techniques.

5. Conclusion

Regression analysis was used to determine the influence of motor variables system (repetitive power and coordination) on the performance of freestyle swimming before and after the swim training program. As a criterion in this analysis, a variable, OCJTEH (swimming for 25 m freestyle technique) was used. By analyzing the presented results of the regression analysis it can be concluded that after the initial measurement of the variables for the assessment of motor abilities the statistically most significant influence on the OCJTEH criterion variation (swimming for 25 m freestyle technique) had variables for the repetitive force estimation, and after the final-evaluation the most influence had variables of coordination. This could be expected, because all the movements in swimming, such as arm movements, legs and the whole body plus breathing are in line with to co-ordination and repetitive power. Based on the presented results of the regression analysis before and after the realization of the swimming program it can be established that there is a very high coefficient of multiple correlation of the motor variables system (repetitive power and coordination) and criterion variables, indicating that the predictive system of motor variables has statistically significant influence on the criterion variable, as well as the results of the final measurement of the free style swimming. The non-swimmers with 73% after the initial measurement were increased to 72% in the final measurement. It should also be emphasized that the percentage of non-swimmers according to the final measurement are students who fall into the category of floaters, while no one has received the 1-E rating, ie remained a complete non-swimmers.

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