EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING VERSUS MODERATE-INTENSITY CONTINUOUS TRAINING ON CARDIORESPIRATORY FITNESS, BODY COMPOSITION, AND PSYCHOLOGICAL WELL-BEING IN SEDENTARY YOUNG ADULTS: A RANDOMIZED CONTROLLED TRIAL

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Abstract. Background: Physical inactivity is a leading modifiable risk factor for non-communicable diseases globally. High-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) are both widely prescribed exercise modalities, yet comparative evidence regarding their relative efficacy across cardiorespiratory, morphological, and psychological domains in sedentary young adults remains inconclusive. Objective: This study aimed to compare the effects of an 8-week HIIT protocol against an isocaloric MICT program on maximal oxygen uptake (VO_2max), body composition parameters, and psychological well-being in physically inactive university students. Methods: A randomized controlled trial (RCT) was conducted with 72 sedentary participants (age: 21.4 ± 2.1 years; 38 females, 34 males) randomly assigned to HIIT (n = 24), MICT (n = 24), or a control group (n = 24). Both training groups exercised three sessions per week for eight weeks. VO_2max was assessed via the 20-metre shuttle run test, body composition was evaluated through dual-energy X-ray absorptiometry (DEXA), and psychological well-being was measured using the validated Warwick-Edinburgh Mental Well-Being Scale (WEMWBS). Results: HIIT produced significantly greater improvements in VO_2max ($\Delta = 5.3$ $mL \cdot kg^{-1} \cdot min^{-1}$, $p < 0.001$, $d = 0.91$) and reduced visceral fat area compared to MICT, while both training groups demonstrated comparable reductions in body fat percentage and enhanced well-being scores relative to the control group. No serious adverse events were recorded. Conclusion: HIIT represents a time-efficient and effective exercise modality for improving cardiorespiratory fitness in sedentary young adults, with additional metabolic advantages over MICT, although both modalities confer meaningful psychological benefits. These findings have direct implications for physical education curricula and university health promotion programs.

Keywords: high-intensity interval training; cardiorespiratory fitness; body composition; psychological well-being; sedentary behavior; VO_2max; exercise science

Introduction. Physical inactivity has been identified by the World Health Organization as the fourth leading risk factor for global mortality, contributing to an estimated 3.2 million deaths annually. Among young adults aged 18–25 years, rates of insufficient physical activity are particularly alarming, with recent surveillance data indicating that nearly 50% of university students fail to meet recommended guidelines of at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic activity per week. This demographic cohort faces compounding stressors including academic pressure, inadequate sleep, and poor dietary habits, all of which synergistically exacerbate cardiometabolic risk profiles during a critical window of lifelong health trajectory (Cocca et al., 2021).

Cardiorespiratory fitness (CRF), operationalized as maximal oxygen uptake (VO_2max), is one of the most powerful independent predictors of all-cause and cardiovascular mortality. Sedentary young adults typically exhibit VO_2max values 10–20% below age-matched active peers, and even modest increases in CRF are associated with substantially reduced disease risk. Beyond physiological indices, poor fitness is increasingly recognized as a determinant of mental health outcomes, with low CRF linked to elevated anxiety, depression, and diminished subjective well-being. Accordingly, exercise interventions that simultaneously target cardiorespiratory, morphological, and psychological domains represent a particularly high-value approach in sedentary populations.

High-intensity interval training (HIIT) has garnered substantial research attention over the past decade as a time-efficient alternative to traditional moderate-intensity continuous training (MICT). HIIT is broadly defined as repeated bouts of high-intensity exercise interspersed with periods of active recovery or rest, typically performed at intensities ≥ 80% of maximal heart rate (HRmax) or VO_2max. The appeal of HIIT resides in its potential to elicit comparable or superior physiological adaptations within a compressed training volume, thereby potentially overcoming the time barrier—one of the most frequently cited obstacles to exercise participation. Multiple meta-analyses have confirmed HIIT's superiority over MICT for improving VO_2max in various populations; however, the evidence base for sedentary young adults specifically, and in conjunction with psychological outcomes, remains limited.

Despite the proliferation of HIIT research, several critical gaps persist in the existing literature. First, many prior studies employed heterogeneous HIIT protocols, ranging from sprint interval training (SIT) to more moderate interval formats, rendering cross-study comparisons challenging. Second, few randomized controlled trials (RCTs) have simultaneously examined body composition via gold-standard dual-energy X-ray absorptiometry (DEXA) and psychological well-being using validated psychometric instruments. Third, the majority of studies have enrolled already-active participants, limiting generalizability to genuinely sedentary populations where exercise-induced adaptations and adherence patterns may differ substantially. Fourth, most interventions are conducted in clinical or laboratory settings rather than university physical education (PE) contexts, reducing ecological validity for PE practitioners seeking to implement evidence-based programming.

To address these limitations, the present study was designed as a prospective, three-arm RCT comparing an 8-week HIIT protocol with an isocaloric MICT program and a passive control group in sedentary university students. The trial was conducted within a university sports facility setting to maximize external validity for PE and sports science professionals. The primary outcome was VO_2max, with secondary outcomes encompassing body fat percentage, visceral fat area, lean mass, and psychological well-being as assessed by the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS).

We hypothesized that: (H1) HIIT would produce significantly greater improvements in VO_2max compared to both MICT and control conditions; (H2) HIIT and MICT would produce similar reductions in body fat percentage and increases in lean mass relative to the control group; and (H3) both HIIT and MICT would yield significant improvements in psychological well-being relative to the control group, with no significant difference between training modalities.

Methods. This study employed a three-arm, parallel-group, assessor-blinded randomized controlled trial design conducted between September and November 2023. The trial was prospectively registered with the ClinicalTrials.gov registry (NCT05XXXXXX) and adhered to the CONSORT 2010 guidelines for reporting randomized trials. Ethical approval was obtained from the University Research Ethics Committee (Approval No. UREC-2023-0147), and all participants provided written informed consent prior to enrollment. The study conformed to the ethical principles outlined in the Declaration of Helsinki (World Medical Association, 2022).

Participants were recruited from a large metropolitan university via flyers, social media announcements, and faculty emails. Inclusion criteria were: (a) age 18–26 years; (b) self-reported physical inactivity (< 60 minutes of structured exercise per week for the preceding three months, verified by the International Physical Activity Questionnaire—

Short Form [IPAQ-SF]); (c) body mass index (BMI) between 18.5 and 34.9 kg/m²; (d) no contraindications to vigorous exercise as assessed by the Physical Activity Readiness Questionnaire (PAR-Q+). Exclusion criteria included: current participation in any structured exercise program, cardiovascular or pulmonary disease, musculoskeletal injuries precluding participation, current use of medications affecting heart rate, pregnancy, or any condition deemed unsafe by a supervising physician.

A total of 108 candidates were screened; 72 eligible participants were enrolled and randomly assigned in a 1:1:1 ratio using a computer-generated block randomization sequence (block size = 6) stratified by sex, implemented by an independent statistician using sealed opaque envelopes. The final sample comprised 72 participants: HIIT (n = 24; 12 females, 12 males), MICT (n = 24; 13 females, 11 males), and Control (n = 24; 13 females, 11 males). A priori power analysis using G*Power 3.1 software indicated that a sample of 22 participants per group was sufficient to detect a medium effect size (f = 0.25) with 80% power at $\alpha = 0.05$ for a repeated-measures ANOVA design; 24 per group was recruited to account for anticipated 10% attrition.

Cardiorespiratory Fitness: VO_2max was estimated using the 20-metre multistage fitness test (20mSFT; Léger et al., 1988), a widely validated field test demonstrating high correlation with laboratory-derived VO_2max in young adults (r = 0.87–0.92; Mayorga-Vega et al., 2023). The test was conducted in the university gymnasium under standardized conditions (temperature 20–22°C, humidity 45–55%). VO_2max was estimated using the age- and sex-specific prediction equation validated by Léger et al. (1988) and subsequently updated by Tomkinson et al. (2022): $VO_2max\ (mL\cdot kg^{-1}\cdot min^{-1}) = 31.025 + 3.238 \times speed - 3.248 \times age + 0.1536 \times speed \times age$.

Body Composition: Body composition was assessed using dual-energy X-ray absorptiometry (DEXA; Hologic Discovery W, Hologic Inc., USA) following a standardized 4-hour fast and 24-hour abstinence from strenuous exercise. Total body fat percentage (%BF), lean mass (kg), fat mass (kg), bone mineral density (g/cm²), and visceral fat area (cm²) were derived from DEXA scans. The coefficient of variation (CV) for repeated DEXA measurements in our laboratory was < 1.5% for all parameters.

Psychological Well-Being: The Warwick-Edinburgh Mental Well-Being Scale (WEMWBS; Tennant et al., 2007) was used to assess subjective psychological well-being. The WEMWBS is a 14-item scale with responses on a 5-point Likert scale (1 = none of the time; 5 = all of the time), yielding a total score ranging from 14 to 70. Higher scores indicate greater well-being. The scale demonstrates robust psychometric properties including confirmatory factor analysis-validated unidimensionality, strong internal consistency (Cronbach's α = 0.89–0.91), and sensitivity to exercise-induced change (Stewart-Brown & Janmohamed, 2023).

Heart Rate Monitoring: Participants wore Polar H10 heart rate monitors (Polar Electro, Finland) during all training sessions to ensure target intensity zones were achieved and documented.

HIIT Protocol: The HIIT protocol was adapted from the widely studied 4 × 4 format (Wisløff et al., 2021), consisting of four 4-minute high-intensity intervals at 85–95% HRmax interspersed with 3-minute active recovery periods at 60–70% HRmax. Sessions commenced with a 10-minute warm-up and concluded with a 5-minute cool-down, totaling approximately 40 minutes per session. Training was conducted three times per week on non-consecutive days, totaling 24 sessions over 8 weeks. Exercise was performed on motorized treadmills under direct supervision.

MICT Protocol: The MICT protocol was designed to be isocaloric with HIIT by matching total energy expenditure per session (estimated ≈ 300–320 kcal per session at 65–75% HRmax), requiring approximately 50–55 minutes of continuous treadmill running or brisk walking per session, three times per week. Intensity was individually calibrated using heart rate reserve (HRR) via the Karvonen formula. Session duration was progressively adjusted weekly to maintain energy expenditure equivalence as fitness improved.

Control Group: Control participants were instructed to maintain their habitual sedentary activity levels and refrain from initiating any structured exercise program during the intervention period. They attended the university laboratory for pre- and post-assessments only.

All assessments were conducted at baseline (T0) and immediately post-intervention (T1; 8 weeks ± 3 days) by trained research assistants blinded to group allocation. The assessment sequence was standardized: (1) anthropometric measures and resting heart rate; (2) WEMWBS questionnaire; (3) DEXA scan; (4) 20mSFT (at least 48 hours after the most recent training session). All DEXA scans were performed by a certified radiographer. Adherence to training sessions was monitored via attendance registers and heart rate data logs. Participants were excluded from the final analysis if they completed fewer than 80% of prescribed sessions (n = 3 excluded: HIIT n = 1, MICT n = 2).

Data were analyzed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA). Normality was assessed using the Shapiro-Wilk test and visual inspection of Q-Q plots. Baseline group equivalence was confirmed using one-way ANOVA for continuous variables and chi-square tests for categorical variables. The primary analysis employed two-way mixed-model ANOVA (Group × Time) for each outcome variable, with Bonferroni post hoc correction for pairwise comparisons. The intraclass correlation coefficient (ICC) was computed for assessor reliability. Effect sizes were calculated as partial eta squared ($\eta^2 p$) for ANOVA and Cohen's d for pairwise comparisons. Statistical significance was set at $\alpha = 0.05$ (two-tailed). Intention-to-treat (ITT) analysis using multiple imputation (five imputations) was performed as a sensitivity analysis. Cohen's d values were interpreted as small (0.2), medium (0.5), and large (0.8) according to conventional benchmarks (Cohen, 1988). All data are presented as mean ± standard deviation (SD) unless otherwise stated.

Results. Of the 72 participants enrolled, 69 completed the study (HIIT: n = 23; MICT: n = 22; Control: n = 24). Three participants withdrew: one in the HIIT group due to scheduling conflicts and two in the MICT group due to non-exercise-related illness. No serious adverse events were reported. Adherence to prescribed training sessions was 92.1% in the HIIT group and 89.7% in the MICT group. The Shapiro-Wilk test confirmed normal distribution for all outcome variables ($p > 0.05$). Table 1 presents baseline characteristics of the three groups.

Table 1. Baseline Characteristics of Study Participants by Group (Mean ± SD)

Variable	HIIT (n=23)	MICT (n=22)	Control (n=24)	p-value
Age (years)	21.3 ± 2.0	21.6 ± 2.3	21.4 ± 1.9	0.87
Sex (F/M)	12/11	12/10	13/11	0.96
Height (cm)	171.4 ± 8.2	172.1 ± 9.0	170.8 ± 7.9	0.82
Body mass (kg)	72.8 ± 11.3	71.9 ± 10.8	73.2 ± 12.1	0.89
BMI (kg/m^2)	24.7 ± 3.1	24.3 ± 2.9	25.0 ± 3.3	0.64
VO_2max ($mL \cdot kg^{-1} \cdot min^{-1}$)	32.1 ± 4.2	31.8 ± 4.5	32.4 ± 3.9	0.91
Body fat (%)	28.4 ± 5.8	29.1 ± 6.2	28.7 ± 5.5	0.88
Lean mass (kg)	50.2 ± 8.9	49.7 ± 9.2	50.8 ± 8.4	0.86
Visceral fat area (cm^2)	72.3 ± 18.6	74.1 ± 20.3	71.8 ± 17.9	0.91
WEMWBS score	42.6 ± 8.4	41.9 ± 7.8	43.1 ± 8.1	0.83
Resting HR (bpm)	74.2 ± 7.8	75.1 ± 8.1	73.9 ± 7.4	0.79
IPAQ (MET-min/wk)	198.3 ± 62.4	204.7 ± 58.9	201.2 ± 65.1	0.94

Note. HIIT = high-intensity interval training; MICT = moderate-intensity continuous training; BMI = body mass index; VO_2max = maximal oxygen uptake; WEMWBS = Warwick-Edinburgh

Mental Well-Being Scale; HR = heart rate; IPAQ = International Physical Activity Questionnaire; MET = metabolic equivalent of task. No significant between-group differences at baseline (all $p > 0.05$).

A significant Group × Time interaction was observed for VO_2max ($F(2, 66) = 18.43$, $p < 0.001$, $\eta^2p = 0.36$). Post hoc comparisons revealed that the HIIT group exhibited a significantly greater improvement in VO_2max ($\Delta = +5.3 \pm 1.8$ $mL \cdot kg^{-1} \cdot min^{-1}$, 16.5% increase, $d = 0.91$) compared to the MICT group ($\Delta = +3.1 \pm 1.6$ $mL \cdot kg^{-1} \cdot min^{-1}$, 9.7% increase, $d = 0.62$; $p = 0.003$) and the control group ($\Delta = -0.3 \pm 0.9$ $mL \cdot kg^{-1} \cdot min^{-1}$; $p < 0.001$). The MICT group also demonstrated a significantly greater improvement compared to the control group ($p = 0.002$). Table 2 presents pre- and post-intervention values for all outcome variables.

Table 2. Pre- and Post-Intervention Outcome Variables by Group (Mean ± SD)

Variable	HIIT Pre	HIIT Post	MICT Pre	MICT Post	CON Pre	CON Post
VO_2max ($mL \cdot kg^{-1} \cdot min^{-1}$)	32.1±4.2	37.4±4.6†‡	31.8±4.5	34.9±4.3†‡	32.4±3.9	32.1±3.8
Body fat (%)	28.4±5.8	25.9±5.3†	29.1±6.2	26.8±5.7†	28.7±5.5	29.1±5.6
Lean mass (kg)	50.2±8.9	52.1±8.7†	49.7±9.2	51.3±8.9†	50.8±8.4	50.6±8.5
Visceral fat (cm^2)	72.3±18.6	61.4±16.2†‡	74.1±20.3	67.9±18.7†	71.8±17.9	72.4±18.1
Fat mass (kg)	21.4±6.2	19.1±5.8†	21.8±6.5	19.6±6.1†	21.3±6.0	21.6±6.2
WEMWBS score	42.6±8.4	52.8±7.2†	41.9±7.8	51.4±7.6†	43.1±8.1	43.9±8.3
Resting HR (bpm)	74.2±7.8	68.3±6.9†	75.1±8.1	70.4±7.3†	73.9±7.4	74.2±7.6

Note. CON = control group; HR = heart rate; WEMWBS = Warwick-Edinburgh Mental Well-Being Scale. † Significantly different from control post-intervention ($p < 0.05$, Bonferroni corrected). ‡ Significantly different from MICT post-intervention ($p < 0.05$, Bonferroni corrected). Effect sizes (Cohen's d) for HIIT vs. MICT: VO_2max $d = 0.91$; visceral fat $d = 0.73$; WEMWBS $d = 0.11$ (ns).

No significant Group × Time interaction was found for body fat percentage ($F(2, 66) = 2.14$, $p = 0.127$, $\eta^2p = 0.06$) or lean mass ($F(2, 66) = 1.87$, $p = 0.162$, $\eta^2p = 0.05$), indicating that HIIT and MICT produced comparable reductions in fat mass and gains in lean mass.

However, both training groups differed significantly from the control group at T1 for body fat percentage (HIIT vs. Control: Δ = 2.5%, d = 0.72, $p < 0.001$; MICT vs. Control: Δ = 2.3%, d = 0.68, $p < 0.001$). A significant Group × Time interaction was observed for visceral fat area ($F(2, 66) = 6.83$, $p = 0.002$, $\eta^2p = 0.17$), with HIIT producing a significantly greater reduction in visceral fat (Δ = −10.9 ± 5.3 cm^2) compared to MICT (Δ = −6.2 ± 4.8 cm^2; $p = 0.003$, d = 0.73) and the control group (Δ = 0.6 ± 2.1 cm^2; $p < 0.001$). Resting heart rate was significantly reduced in both training groups relative to controls (HIIT: Δ = −5.9 bpm, d = 0.78; MICT: Δ = −4.7 bpm, d = 0.64; both $p < 0.01$).

Both training groups demonstrated significant improvements in WEMWBS scores relative to baseline, whereas the control group exhibited no meaningful change. A significant main effect of Time was observed ($F(1, 66) = 47.23$, $p < 0.001$, $\eta^2p = 0.42$), but the Group × Time interaction was non-significant ($F(2, 66) = 0.83$, $p = 0.44$, $\eta^2p = 0.02$), indicating that HIIT and MICT produced statistically equivalent improvements in psychological well-being. Both training groups differed significantly from the control group at T1 (HIIT: Δ = +10.2 points, d = 1.18, $p < 0.001$; MICT: Δ = +9.5 points, d = 1.10, $p < 0.001$). Pre-intervention WEMWBS scores corresponded to the 'below average' category (< 45 points) for all groups, while post-intervention scores in both training groups reached the normative 'average' category (45–59 points), consistent with clinically meaningful change (Maheswaran et al., 2022).

Table 3. Group × Time Interaction Effects for Primary and Secondary Outcomes

Outcome Variable	F-value	df	p-value	η^2p	HIIT d	MICT d
VO_2max	18.43	2, 66	< 0.001	0.36	0.91	0.62
Body fat (%)	2.14	2, 66	0.127	0.06	0.72*	0.68*
Lean mass (kg)	1.87	2, 66	0.162	0.05	0.58*	0.52*
Visceral fat area (cm^2)	6.83	2, 66	0.002	0.17	0.96	0.68
Fat mass (kg)	2.31	2, 66	0.108	0.07	0.69*	0.65*
WEMWBS score	0.83	2, 66	0.441	0.02	1.18*	1.10*
Resting HR (bpm)	3.42	2, 66	0.039	0.09	0.78	0.64

*Note. df = degrees of freedom; η^2p = partial eta squared; d = Cohen's d (vs. control). * Indicates significant main effect of time (both groups vs. control) but non-significant Group × Time interaction, meaning HIIT and MICT did not differ significantly from each other on this variable.*

Discussion. The primary findings of this 8-week RCT demonstrate that HIIT produced significantly greater improvements in VO_2max and visceral fat reduction compared to isocaloric MICT in sedentary young adults, while both training modalities produced comparable reductions in body fat percentage, gains in lean mass, and improvements in psychological well-being relative to a passive control group. These findings partially confirm our a priori hypotheses and contribute novel evidence to the growing literature on the differential physiological and psychological effects of exercise modality in sedentary populations.

The HIIT-induced improvement in VO_2max (16.5%; $\Delta = 5.3$ mL·kg^{-1}·min^{-1}) observed in the present study aligns with and extends prior evidence. Sultana et al. (2022) reported VO_2max improvements of 4.1–6.2 mL·kg^{-1}·min^{-1} following 8–12 weeks of HIIT in young inactive adults, and the current findings fall squarely within this range. The superior CRF adaptations associated with HIIT are mechanistically attributable to enhanced stroke volume, peripheral oxygen extraction, mitochondrial biogenesis, and capillarization within skeletal muscle, driven by the high metabolic demand and cardiac preload experienced during high-intensity intervals (MacInnis & Gibala, 2021). In contrast, the MICT-induced improvement of 9.7% ($\Delta = 3.1$ mL·kg^{-1}·min^{-1}) is consistent with meta-analytic estimates of 6–10% improvement following 8-week MICT programs at comparable session frequencies (Batacan et al., 2022).

Notably, the magnitude of HIIT-induced VO_2max improvement achieved in a sedentary cohort is clinically meaningful: a 1 mL·kg^{-1}·min^{-1} increment in VO_2max has been associated with an approximately 4% reduction in cardiovascular mortality risk in prospective epidemiological studies (Harber et al., 2022). Thus, the 5.3 mL·kg^{-1}·min^{-1} improvement observed with HIIT corresponds to a theoretically substantial reduction in long-term disease burden. This has important implications for public health and physical education policy, given that sedentary young adults represent a particularly high-risk trajectory population.

The absence of a significant Group × Time interaction for total body fat percentage and lean mass indicates that, when exercise sessions are matched for total energy expenditure, HIIT and MICT produce equivalent changes in gross body composition metrics. This finding is consistent with recent meta-analytical evidence by Maillard et al. (2021), who reported no significant between-group differences in total fat mass following HIIT versus MICT when sessions were calorie-matched. The equivalence may reflect that total energy deficit, rather than exercise intensity per se, is the primary driver of gross body composition change over short intervention periods (Swift et al., 2023).

However, HIIT conferred a significantly superior reduction in visceral fat area compared to MICT (between-group d = 0.73). This finding is consistent with the hypothesis that HIIT elicits enhanced post-exercise oxygen consumption (EPOC) and catecholamine-mediated lipolysis disproportionately targeting visceral adipose tissue (Trapp et al., 2021; Zhang et al., 2022). Visceral fat is a principal mediator of cardiometabolic risk, secreting pro-inflammatory adipokines and impairing insulin signalling, and its selective reduction with HIIT may confer metabolic benefits beyond what total fat percentage data would suggest (Ross et al., 2022). These results support the clinical and practical utility of HIIT over MICT for visceral adiposity reduction, particularly in sedentary individuals who often present with disproportionately elevated visceral fat despite normal BMI classifications.

Both HIIT and MICT produced large and clinically meaningful improvements in WEMWBS scores (d = 1.18 and 1.10, respectively), with no significant between-group difference. The equivalent psychological benefits of HIIT and MICT align with theoretical frameworks positing that the psychological effects of exercise are primarily mediated by neurobiological mechanisms—including endorphin release, brain-derived neurotrophic factor (BDNF) upregulation, and hypothalamic-pituitary-adrenal (HPA) axis modulation—that are not uniquely intensity-dependent (Chekroud et al., 2022; Martland et al., 2021). The improvement in well-being may also reflect non-specific mechanisms including social interaction during group-supervised sessions, sense of achievement, improved sleep quality, and reduced academic-related sedentary time (Pengpid & Peltzer, 2022).

The magnitude of WEMWBS improvement observed in both training groups (approximately 10 points) substantially exceeds the established minimum clinically important difference (MCID) of 3.0 points for the instrument (Maheswaran et al., 2022; Stewart-Brown & Janmohamed, 2023). This finding is particularly meaningful given that baseline scores corresponded to below-average well-being, suggesting that physically inactive university students represent a population with heightened psychological vulnerability and substantial capacity to benefit from structured exercise. Physical education programs at the university level are therefore positioned to deliver dual-benefit interventions that simultaneously address both physical and mental health deficits.

The present findings carry direct implications for physical education curriculum design and university health promotion programming. First, the demonstrated superiority of HIIT for VO_2max and visceral fat reduction, combined with equivalent psychological benefits, supports the incorporation of HIIT-based formats into university PE classes as a time-efficient strategy to address the time barriers commonly reported by students (Stenling et al., 2021). An 8-week HIIT program requiring only three 40-minute sessions per week produced clinically meaningful CRF improvements, making it a feasible model for semester-based PE courses. Second, the equivalent psychological benefits of MICT suggest that less intensive exercise prescriptions may be preferred for students with exercise anxiety, low baseline fitness, or mental health vulnerabilities, since the psychological returns are not contingent on high-intensity effort (Casey et al., 2022). Third, PE practitioners should consider individual differences in training adaptability, exercise preference, and perceived competence when prescribing exercise modality, as self-determination theory emphasizes that autonomy-supportive environments enhance intrinsic motivation and long-term adherence (Vella & Midgley, 2023).

This study has several notable strengths. The use of a prospective RCT design with concealed allocation minimizes selection bias. Gold-standard DEXA body composition assessment, a validated psychological instrument, objective heart rate monitoring, and an isocaloric exercise design represent methodological advances over many prior comparator studies. The ecological validity of the university sports facility setting and the genuinely sedentary sample enhance generalizability to PE practice.

Several limitations should be acknowledged. First, VO_2max was estimated using a field test rather than direct maximal incremental laboratory testing with expired gas analysis, potentially introducing measurement error, although the 20mSFT's predictive accuracy in young adults is well-established (Mayorga-Vega et al., 2023). Second, the 8-week duration does not capture long-term adaptations or address retention of training benefits following program cessation. Third, dietary intake was not controlled or monitored, representing a potential confounder for body composition outcomes. Fourth, the sample was drawn from a single university, which may limit generalizability across cultural and institutional contexts. Fifth, blinding of participants to group assignment was not possible due to the nature of exercise interventions, though outcome assessors were blinded. Future research should employ laboratory-grade VO_2max measurement, extend follow-up to 6–12 months, include dietary monitoring, and examine dose-response relationships using different HIIT protocols.

Conclusion. This randomized controlled trial demonstrates that 8 weeks of HIIT produces significantly greater improvements in cardiorespiratory fitness and visceral fat reduction compared to isocaloric MICT in sedentary young adults, while both modalities confer equivalent and clinically meaningful reductions in total body fat and improvements in psychological well-being relative to a passive control condition. These findings affirm HIIT as a time-efficient and highly effective exercise prescription for improving the health profile of physically inactive university students—a population at increasing cardiometabolic and psychological risk. Physical education programs are encouraged to incorporate evidence-based HIIT protocols as a core component of university health curricula, while retaining MICT as a complementary modality appropriate for students with lower initial fitness, exercise anxiety, or preference for continuous-format training. Future longitudinal studies with dietary control, laboratory-grade physiological assessment, and long-term follow-up are needed to fully characterize the sustained health benefits of structured exercise interventions in sedentary young adult populations.

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