PHYSICAL EDUCATION OF STUDENTS

ORIGINAL ARTICLE

The effect of a 10-week aerobic exercise program on cardiorespiratory endurance and resting heart rate in university students

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim Physical inactivity during young adulthood is associated with reduced cardiorespiratory fitness and elevated resting heart rate. Both are predictors of long-term cardiovascular risk. The present study aimed to examine the effects of a 10-week structured aerobic exercise program on cardiorespiratory endurance and resting heart rate in sedentary university students.

Material and Methods This controlled experimental study employed a pretest–posttest design with an exercise group (n = 15) and a control group (n = 10). Participants were sedentary individuals aged 18–25 years. The exercise group completed supervised aerobic training three days per week for 10 weeks at 50–75% of maximum heart rate. The control group maintained usual daily activities. Cardiorespiratory endurance was assessed using the Cooper 12-minute run test. Resting heart rate was measured under standardized seated conditions. Data were analyzed using IBM SPSS Statistics (Version XX). Normality was assessed via the Shapiro–Wilk test. Between- and within-group comparisons were performed using independent and paired samples t-tests (or non-parametric equivalents where appropriate). Effect sizes (Cohen's d) were calculated based on pooled standard deviations of change scores.

Results The exercise group demonstrated significant improvements in cardiorespiratory endurance (p = .01; d = 0.98) and significant reductions in resting heart rate (p = .007; d = 1.21). No significant changes were observed in the control group.

Conclusions A 10-week aerobic exercise program significantly improves cardiorespiratory endurance and lowers resting heart rate in sedentary young adults. Given the modest sample size, the findings should be interpreted as moderate-to-large effect estimates that require confirmation in larger trials.

Keywords: aerobic exercise, cardiorespiratory endurance, resting heart rate, sedentary lifestyle, university students

Introduction

Regular physical activity plays a central role in maintaining cardiovascular health and functional capacity during early adulthood. Cardiorespiratory endurance and resting heart rate are widely used physiological indicators reflecting the efficiency of the cardiovascular system and the overall level of physical fitness. Reduced levels of cardiorespiratory fitness together with elevated resting heart rate are associated with less favorable cardiovascular functioning and may indicate decreased adaptive capacity of the organism. In populations of young adults, lifestyle patterns characterized by limited physical activity can negatively influence these indicators and contribute to less optimal physiological regulation. This trend reflects a broader shift toward sedentary behavior observed in modern societies.

A sedentary lifestyle has emerged as a major public health concern, particularly among young adults, due to a marked decline in daily physical activity levels. The World Health Organization identifies physical inactivity as one of the leading risk factors for cardiovascular diseases, metabolic disorders, and premature mortality [1]. The increasing prevalence of sedentary behaviors during young adulthood adversely affects cardiovascular function, leading to reductions in cardiorespiratory endurance and overall physical fitness [2].

Cardiorespiratory endurance is defined as the ability of the cardiovascular and respiratory systems to supply oxygen to working muscles during prolonged physical activity and to utilize this oxygen efficiently. Higher levels of cardiorespiratory endurance are strongly associated with a reduced risk of cardiovascular disease and all-cause mortality [3, 4]. Conversely, low cardiorespiratory endurance is closely linked to physical inactivity. It is also considered an independent predictor of adverse health outcomes [5]. Therefore, improving cardiorespiratory endurance is a primary target in exercise-based health promotion strategies.

Resting heart rate is another important physiological indicator of cardiovascular health

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and autonomic nervous system regulation. A lower resting heart rate reflects enhanced parasympathetic activity and greater cardiovascular efficiency. In contrast, an elevated resting heart rate is associated with an increased risk of cardiovascular morbidity and mortality [6]. Previous studies have demonstrated that resting heart rate is a modifiable parameter. It responds favorably to regular physical activity and aerobic exercise interventions [7].

Aerobic exercise involves rhythmic and continuous movements of large muscle groups. It is widely recognized for its positive effects on the cardiovascular and respiratory systems. Regular participation in aerobic exercise has been shown to improve stroke volume and enhance myocardial efficiency. It also induces favorable adaptations in autonomic regulation. These adaptations result in increased cardiorespiratory endurance and decreased resting heart rate in sedentary individuals [2, 8, 9]. Despite these well-documented benefits, sedentary behavior remains highly prevalent among university-aged populations. Controlled experimental studies that compare exercise and control groups provide robust evidence regarding the physiological effects of structured exercise interventions. In addition, including both female and male participants allows for a more comprehensive evaluation of exercise-induced adaptations in young adults [10].

Analysis of research findings has shown that regular aerobic exercise contributes significantly to improvements in cardiorespiratory endurance and to favorable adaptations in cardiovascular regulation. Researchers emphasize that higher levels of cardiorespiratory fitness and lower resting heart rate are important indicators of cardiovascular health. They are strongly associated with reduced risks of cardiovascular diseases and adverse health outcomes. Authors also highlight the role of structured physical activity in promoting physiological adaptations that enhance cardiovascular efficiency and autonomic balance in young adults. At the same time, the growing prevalence of sedentary behavior among university-aged populations underscores the importance of further examining how structured aerobic exercise programs influence key cardiovascular parameters in this group. This gap continues to limit a comprehensive understanding of the physiological responses to aerobic exercise in sedentary young adults. It also highlights the need for further investigation in this area. However, there is still a need for controlled studies that examine the effects of structured aerobic exercise programs on key cardiovascular parameters in sedentary young populations.

Therefore, the purpose of this study is to investigate the effects of a 10-week aerobic exercise program on cardiorespiratory endurance and resting heart rate in sedentary females and males aged 18–25 years. It is hypothesized that participants who engage in the aerobic exercise program will demonstrate significant improvements in cardiorespiratory endurance. They will also demonstrate significant reductions in resting heart rate compared with a control group that does not participate in structured exercise.

Materials and Methods

Participants

The study sample consisted of 25 sedentary volunteers aged 18–25 years. Sedentary status was defined as not participating in regular physical activity at least three days per week during the previous six months. Participants were divided into an exercise group (N = 15; 8 females, 7 males) and a control group (N = 10; 6 females, 4 males).

The inclusion criteria were age between 18 and 25 years, absence of cardiovascular, respiratory, or neuromuscular disorders, and willingness to participate in the exercise program for the full duration of the study. The exclusion criteria included a history of chronic disease, regular medication use, or orthopedic conditions that could interfere with participation in exercise.

The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants before the commencement of the study.

Research Design

This study evaluated two primary physiological outcomes: cardiorespiratory endurance and resting heart rate. These variables represent related but physiologically distinct domains of cardiovascular adaptation (functional aerobic capacity vs. autonomic cardiac regulation). Given the limited number of primary outcomes and their conceptual independence, no formal multiplicity correction was applied.

This study was conducted using a controlled experimental design with a pretest–posttest setup and a control group. Participants in the exercise group completed a structured aerobic exercise program three days per week for 10 weeks (Table 1). Participants in the control group continued their usual daily routines.

All exercise sessions were supervised and performed in a gym setting. Each session included a 10-minute warm-up, a 25–40 minute main exercise phase, and a 5–10 minute cool-down. Exercise intensity was prescribed as a percentage of maximum heart rate (HRmax = 220 − age) [11].

Cardiorespiratory endurance was assessed using the Cooper 12-minute run test. Participants were instructed to cover the maximum possible distance within 12 minutes. Resting heart rate was measured in the morning after participants

Table 1. 10-Week Aerobic Exercise Program

Weeks	Frequency	Duration (min)	Intensity (%HRmax)	Exercise Type
1–2	3 days/week	45	50–60	Brisk walking
3–4	3 days/week	50	60	Brisk walking + light jogging
5–6	3 days/week	55	60–70	Continuous jogging
7–8	3 days/week	60	70	Continuous jogging
9–10	3 days/week	60	70–75	Jogging / brisk walking

had rested in a seated position for at least five minutes. Measurements were conducted using manual palpation or a heart rate monitor. They were recorded in beats per minute (bpm). Pretest and posttest measurements were conducted under identical conditions.

Power Analysis

An a priori power analysis was conducted using G*Power 3.1 for repeated-measures comparisons (within–between interaction), assuming a medium effect size (f = 0.25), α = .05, and power (1−β) = .80. The estimated required total sample size was 34 participants. The final analyzed sample (N = 25) did not fully reach the calculated target. Therefore, this study should be interpreted as having adequate sensitivity primarily for detecting moderate-to-large effects rather than small effects. The findings are considered confirmatory for large effects but exploratory for smaller magnitudes.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics (Version 25, IBM Corp., Armonk, NY, USA). Normality: Shapiro–Wilk test. Within-group comparisons: Paired-samples t-test (Wilcoxon test if non-normal). Between-group comparisons: Independent-samples t-test (Mann–Whitney U test if non-normal). To evaluate intervention effects, change scores (posttest − pretest) were calculated and compared between groups.

Cohen's *d* was calculated using the following formulas.

For within-group effects:

$$d = \frac{Mean_{post} - Mean_{pre}}{SD_{pooled}}$$

For between-group change comparisons:

$$d = \frac{Mean_{change,er} - Mean_{change,con}}{SD_{pooled-change}}$$

Where,

$Mean_{post}$ — mean value of the variable measured after the intervention (posttest).

$Mean_{pre}$ — mean value of the variable measured before the intervention (pretest).

SD_{pooled} — pooled standard deviation of the pretest and posttest measurements within the same group.

$Mean_{change,er}$ — mean change score in the exercise (experimental) group, calculated as (posttest − pretest).

$Mean_{change,con}$ — mean change score in the control group, calculated as (posttest − pretest).

$SD_{pooled-change}$ — pooled standard deviation of the change scores in the exercise and control groups.

Effect sizes were interpreted as follows: 0.2 = small, 0.5 = medium, 0.8 = large.

Results

The findings regarding the effects of the 10-week aerobic exercise program on **cardiorespiratory** endurance and resting heart rate in sedentary university students are presented in Table 2. Statistical significance was set at $p < .05$. Both within-group changes and between-group differences in change scores were evaluated.

Table 2. Baseline Characteristics of Participants

Variable	Exercise Group (n = 15) Mean ± SD	Control Group (n = 10) Mean ± SD	p
Age (years)	21.3 ± 2.0	21.6 ± 2.2	.71
Height (cm)	168.1 ± 6.2	167.3 ± 6.7	.76
Body Weight (kg)	62.8 ± 8.4	61.6 ± 9.1	.68
BMI (kg/m²)	22.2 ± 2.5	22.0 ± 2.8	.84
Cooper Test (km)	21.4 ± 2.1	22.1 ± 2.3	.42
Resting Heart Rate (bpm)	78.6 ± 6.4	77.9 ± 7.1	.81

Baseline comparisons showed no statistically significant differences between the exercise and control groups for age, anthropometric variables, or physiological measures ($p > .05$). These results indicate that the groups were comparable before the intervention.

Pretest and posttest results for cardiorespiratory endurance, assessed using the Cooper 12-minute run test, are presented in Table 3.

The exercise group demonstrated a statistically significant increase in the distance covered during the Cooper test following the 10-week intervention ($p = .01$), representing a large effect size ($d = 0.98$). In contrast, the control group showed no significant change ($p = .84$) and a trivial effect size ($d = 0.09$). Between-group comparison of change scores indicated a statistically significant improvement favoring the exercise group ($p < .05$).

Resting heart rate measurements before and

Table 3. Changes in Cardiorespiratory Endurance

Group	Pretest (Mean ± SD)	Posttest (Mean ± SD)	Mean Change	p	Cohen's d
Exercise Group	21.4 ± 2.1	25.6 ± 2.4	+4.2	.01*	0.98
Control Group	22.1 ± 2.3	22.4 ± 2.2	+0.3	.84	0.09

Table 4. Changes in Resting Heart Rate

Group	Pretest (Mean ± SD)	Posttest (Mean ± SD)	Mean Change	p	Cohen's d
Exercise Group	78.6 ± 6.4	71.2 ± 5.8	−7.4	.007*	1.21
Control Group	77.9 ± 7.1	77.1 ± 6.9	−0.8	.531	0.11

after the intervention are presented in Table 4.

The exercise group exhibited a statistically significant reduction in resting heart rate after the 10-week aerobic exercise program (p = .007), corresponding to a large effect size (d = 1.21). The control group showed no significant change (p = .531), with a negligible effect size (d = 0.11). The significant reduction in resting heart rate observed exclusively in the exercise group supports the effectiveness of the aerobic training intervention.

Discussion

The present study examined the effects of a 10-week structured aerobic exercise program on cardiorespiratory endurance and resting heart rate in sedentary university students aged 18–25 years. The findings demonstrate that regular aerobic exercise produced statistically significant and practically meaningful improvements in both physiological parameters when compared to a non-exercising control group.

The exercise group exhibited a significant increase in Cooper 12-minute run performance (p = .01), with a large effect size (d = 0.98), whereas the control group showed no meaningful change. These findings are consistent with previous research demonstrating that aerobic training improves aerobic capacity, stroke volume, peripheral oxygen utilization, and overall cardiovascular efficiency [12, 13], as well as with more recent studies reporting improvements in endurance performance and aerobic physiological adaptations following structured training interventions [14, 15].

Short-term aerobic interventions (8–12 weeks) have been shown to induce measurable improvements in cardiorespiratory fitness in previously sedentary individuals [16], supporting the results of the present study. Similar improvements in cardiorespiratory fitness following structured exercise interventions have also been reported in more recent randomized controlled trials examining inactive or overweight populations [17, 18]. Although maximal oxygen uptake (VO_2max) was not directly measured via metabolic gas analysis, improvements in Cooper test performance are widely accepted as valid field-based indicators of enhanced aerobic fitness. Therefore, the observed increase in running distance likely reflects improved cardiorespiratory function and aerobic work capacity.

A significant reduction in resting heart rate was observed in the exercise group (p = .007), with a large effect size (d = 1.21), whereas the control group showed no significant change. This finding aligns with prior evidence indicating that aerobic exercise enhances myocardial efficiency and autonomic regulation [9, 19], as well as with more recent research demonstrating exercise-induced improvements in cardiac autonomic modulation and cardiovascular function following structured training programs [20, 21]. Reductions in resting heart rate are commonly attributed to improved stroke volume and increased parasympathetic (vagal) activity accompanied by reduced sympathetic tone [9]. However, it should be noted that autonomic markers such as heart rate variability were not directly measured in this study. Therefore, while the decrease in resting heart rate is consistent with improved autonomic balance, mechanistic explanations remain theoretical rather than empirically verified within the present research.

Furthermore, sedentary individuals who do not participate in structured exercise programs typically demonstrate minimal cardiovascular change over similar time periods [2], which is consistent with the absence of significant change observed in the control group. Recent research examining sedentary behavior and reductions in sitting time has similarly demonstrated that low levels of physical activity are associated with limited cardiovascular adaptation and adverse cardiometabolic profiles [22, 23]. The magnitude of reduction observed (−7.4 bpm) may be considered clinically relevant, as elevated resting heart rate has been associated with increased cardiovascular morbidity and mortality risk [6]. Thus, these findings suggest that structured aerobic exercise may contribute to cardiovascular risk reduction even in young, apparently healthy adults.

Practical Implications

The results reinforce the importance of implementing structured aerobic exercise programs in university populations. Given that sedentary behavior remains prevalent among young adults [2], practical and accessible aerobic training models such as brisk walking and jogging may serve as effective interventions to improve cardiovascular health.

Limitations and Future Research

Although statistically significant effects were observed, the relatively modest sample size limits the precision of effect estimation and the generalizability of the findings. The study was adequately sensitive for detecting moderate-to-large effects but may have been underpowered for identifying smaller changes in the analyzed variables. In addition, the sample consisted of sedentary university students within a limited age range, which restricts the applicability of the results to other population groups with different activity levels or demographic characteristics. Therefore, the findings should be interpreted with caution. Future studies should confirm these results in larger randomized trials and examine the effectiveness of aerobic exercise programs across more diverse student populations.

Conclusions

In conclusion, a 10-week aerobic exercise program significantly improved cardiorespiratory endurance and reduced resting heart rate in sedentary individuals aged 18–25 years. These findings indicate that regular aerobic exercise enhances cardiovascular efficiency and overall physical fitness. It also mitigates the negative effects of a sedentary lifestyle. The lack of significant changes in the control group supports the effectiveness of the exercise intervention. Promoting regular aerobic exercise in young adults may contribute to the adoption of healthy lifestyle habits and the reduction of long-term cardiovascular risk. Future research should explore different exercise protocols and larger populations to expand and confirm these findings.

Conflict of Interest

The authors declare no conflict of interest.

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