Journal of Physical Exercise Research
https://journal.sainspenapublisher.com/jpers E-ISSN: 3124-5099

ORIGINAL ARTICLE

Comparison of the Effects of Aerobic and Anaerobic Exercise on Increasing Cardiorespiratory Endurance in Non-Athlete Students

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Received: 16 November 2025
Accepted: 17 November 2025
DOI: https://doi.org/10.68773/jpers.v1i01.7

Abstract:
Background: Cardiorespiratory endurance is a primary indicator of physical fitness that describes the ability of the heart, lungs, and muscles to utilize oxygen optimally. Decreased cardiorespiratory endurance is often found in non-athlete students with low physical activity. Aerobic and anaerobic exercise are two types of exercise that can improve fitness, but have different physiological adaptation mechanisms. Objective: To analyze the comparative effect of aerobic and anaerobic exercise on improving cardiorespiratory endurance in non-athlete students. Methods: This study used a quasi-experimental design with a pre-test and post-test control group approach. The sample consisted of 30 non-athlete students aged 18–22 years who were divided into two groups: aerobic exercise (30 minutes of running, intensity 60–70% HRmax) and anaerobic exercise (30-second sprint intervals with 60 seconds of rest). Cardiorespiratory endurance was measured using the Cooper 12-Minute Run Test and converted to VO_2Max values. Data analysis used paired t-test and independent t-test with $\alpha = 0.05$. Results: Both types of exercise significantly increased VO_2Max ($p < 0.05$). The average increase in VO_2Max in the aerobic group was 4.8 mL/kg/min, while in the anaerobic group it was 3.1 mL/kg/min. The independent t-test results showed a significant difference between the two groups ($p = 0.021$), with aerobic exercise providing a greater increase. Conclusion: Aerobic exercise is more effective than anaerobic exercise in improving cardiorespiratory endurance in non-athlete students. The combination of both can be used as a training strategy to improve general fitness.
Keywords: VO_2Max; aerobic exercise; anaerobic exercise; cardiorespiratory fitness; non-athlete students.

1. Introduction

Exercise is widely recognized as an essential component of a healthy lifestyle, with over 80% of adults worldwide recognizing its positive impact on physical and mental well-being. According to the World Health Organization (2020), regular exercise is associated with a reduced risk of chronic diseases such as cardiovascular disease, diabetes, and depression, underscoring its importance. Furthermore, growing evidence supports the integration of physical activity into public health recommendations and daily routines (Dobarrio-sanz, 2022). In addition to its physical benefits, regular exercise plays an important role in improving mental health by alleviating symptoms of anxiety and depression, and improving cognitive function (Herbert, 2022). The two main categories of exercise, aerobic and anaerobic, have different physiological effects on the body (Pellegrino, 2022).

Aerobic exercise, which is characterized by sustained moderate-intensity activity and relies on oxygen for energy production, is known for its cardiovascular benefits and ability to improve endurance (Franklin et al., 2022). This type of exercise also contributes to improving blood fat levels (lipid profile), reducing inflammation, and increasing insulin sensitivity (the body's ability to respond to insulin and regulate blood sugar levels) (Hamdan et al., 2024). Anaerobic exercise, on the other hand, involves short periods of high-intensity activity that does not rely on oxygen for energy production and is associated with increased muscle strength and power (Atakan & Li, 2021). Additionally, anaerobic exercise increases resting metabolic rate and supports bone density, making it highly beneficial for long-term musculoskeletal health (Spriet, 2022).

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While both forms of exercise offer significant health benefits, their impact on body composition and hormonal adaptations differs, particularly when comparing athletes with non-athletes. Athletes, due to their regular training and higher fitness levels, respond differently to training stimuli than non-athletes. Specifically, trained athletes exhibit superior mitochondrial function and recovery capacity, allowing them to adapt more efficiently to high-intensity exercise (Daussin et al., 2025). Understanding these differences in effects is critical to developing targeted training programs and optimizing performance in both athletic and non-athletic populations.

Cardiorespiratory endurance is a key component of physical fitness that plays a crucial role in maintaining the body's physiological functions. This parameter is measured by maximal oxygen consumption (VO_2Max), which is the body's capacity to transport and utilize oxygen during intense activity. A high VO_2Max value indicates good cardiovascular and respiratory system efficiency. Non-athlete students often exhibit low levels of cardiorespiratory fitness due to a sedentary lifestyle, such as prolonged sitting, lack of exercise, and irregular sleep patterns. Aerobic exercise such as moderate-distance running, cycling, or swimming has been shown to improve oxygen transport efficiency by increasing stroke volume, muscle capillarization, and aerobic enzyme activity (Mollard et al., 2007). In contrast, anaerobic exercise such as interval sprints can improve lactic acid tolerance, phosphagen capacity, and muscle strength (Patel et al., 2017). While both contribute to fitness, their relative effectiveness on cardiorespiratory endurance still requires further study. This study aims to analyze and compare the effects of aerobic and anaerobic exercise on improving cardiorespiratory endurance in non-athlete students, as a reference in developing physiotherapy and general fitness training programs.

2. Materials and Methods

This study used a quasi-experimental design with a pre-test and post-test control group approach. The sample consisted of 30 non-athlete college students aged 18–22 who met the inclusion criteria: physically fit, non-smokers, and not participating in a regular exercise program.

Respondents were randomly divided into two groups:

• Aerobic Group: Performed 30-minute running exercises at an intensity of 60–70% of maximum heart rate (HRmax) 3 times per week for 4 weeks.

• Anaerobic Group: Performed interval sprint training (30-second sprints with 60-second rest periods) 8 sets per session, 3 times per week for 4 weeks.

Cardiorespiratory endurance was measured using the Cooper 12-Minute Run Test, and the results were converted to VO_2Max values using the formula:

$$VO_2Max = (distance" \, in \, meters" - 504.9)/44.73$$

Data were analyzed using paired t-tests for pre- and post-exercise differences within groups, and independent t-tests for comparisons between groups.

3. Results

Both groups experienced significant increases in VO_2Max ($p < 0.05$).

• Aerobic group: The mean value increased from 35.7 ± 4.2 to 40.5 ± 3.8 mL/kg/min ($\Delta = +4.8$).

• Anaerobic group: The mean value increased from 36.1 ± 4.0 to 39.2 ± 3.7 mL/kg/min ($\Delta = +3.1$).

Independent t-test results showed a significant difference between the two groups ($p = 0.021$), with aerobic exercise showing a greater increase in VO_2Max.

4. Discussion

The purpose of this study was to determine the effect of aerobic and anaerobic exercise on cardiorespiratory endurance. The results showed that aerobic exercise was more effective than anaerobic exercise in improving cardiorespiratory endurance in non-athlete students. Physiologically, aerobic exercise increases the capacity of the cardiovascular system by increasing stroke volume, capillary density, and oxidative enzyme activity. These adaptations improve the body's ability to use oxygen efficiently during prolonged activity (Mollard et al., 2007). In contrast, anaerobic exercise relies on oxygen-free metabolism, which is dominant at high intensities and short durations. The primary adaptation of this exercise is an increase in phosphagen and glycolytic capacity, which favors power and speed over long-term endurance (Patel et al., 2017).

Regular aerobic exercise induces significant adaptations both at rest and during maximal exercise in various dimensional and functional capacities related to the cardiovascular and respiratory regulatory systems, thereby improving oxygen delivery to active muscles. These changes include a decrease in resting and maximal exercise heart rate and an increase in stroke volume and cardiac output (Fagard, 2001). The decrease in heart rate, systolic blood pressure (SBP), and diastolic blood pressure (DBP) in the aerobic exercise group after aerobic exercise may be due to nitric oxide, an important and potent relaxation factor derived from the endothelium that facilitates blood vessel dilation and decreases vascular resistance (Joyner & Tschakovsky, 2003).

The results of previous studies showed that there were no significant changes in heart rate or systolic blood pressure (SBP) and diastolic blood pressure (DBP) in the anaerobic exercise group after completion of the anaerobic exercise program, but there was a significant decrease after the aerobic exercise program (Amer & Samira., 2015). This reflects the increased cardiorespiratory load associated with increasing the duration of the exercise session from 20 to 30 minutes. However, the greater blood flow due to the increased HR and SBP does not meet the increased oxygen demand during anaerobic exercise. This explains the significant increase in pulmonary ventilation and ventilatory capacity in an effort to meet the increased oxygen transport demand during maximal exercise. Participating in anaerobic exercise with high resistance for prolonged periods increases the workload of the heart and cannot be sustained over long periods. However, the combination of both types of exercise can have a synergistic effect on overall fitness. In the context of physiotherapy, aerobic exercise is recommended for individuals with low physical activity or those undergoing cardiopulmonary rehabilitation programs. Anaerobic exercise, on the other hand, is beneficial for increasing muscle strength and anaerobic capacity in individuals with moderate to high fitness.

Research Limitations

This study has limitations because the number of respondents is small and is limited to anaerobic and aerobic exercise interventions only and their impact on cardiorespiratory endurance.

Directions for Future Research

Further research could explore the effects of skipping both aerobic and anaerobic physical exercise on molecular biomarkers for laboratory testing.

5. Conclusions

Skipping significantly increased VO_2Max in extracurricular basketball participants at Pirngadi Christian High School, Surabaya. This exercise is recommended as an easy, inexpensive, and effective aerobic exercise alternative to improve cardiorespiratory endurance in students.

Acknowledgement

Both aerobic and anaerobic exercise are effective in improving cardiorespiratory endurance in non-athlete college students, but aerobic exercise provides a more significant increase in VO_2Max. A combination of both types of exercise can be a balanced training strategy to improve general fitness and physical performance.

Conflict of Interest

The authors declare no conflict of interest.

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