

Effectiveness of Aerobic Exercise on Improving Cardiorespiratory Endurance in Adolescent Girls: A Quasi-Experimental Study

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ABSTRACT

Cardiorespiratory endurance is an essential component of physical fitness that plays an important role in supporting daily physical activities and maintaining overall health. Adolescent females, particularly university students, often experience decreased physical activity levels due to prolonged academic activities performed in sitting positions, leading to sedentary lifestyles and reduced cardiorespiratory capacity. Aerobic exercise is considered an effective physical activity intervention to improve cardiovascular and respiratory function as well as oxygen utilization efficiency in the body. This study aimed to determine the effectiveness of aerobic exercise in improving cardiorespiratory endurance among adolescent females. This study employed a quasi-experimental design using a one-group pre-test and post-test approach without a control group. The participants consisted of 10 female physiotherapy students who met the inclusion criteria. The aerobic exercise intervention, in the form of aerobic gymnastics, was conducted for four weeks with a frequency of three sessions per week. Cardiorespiratory endurance was measured using the Harvard Step Test to obtain participants' fitness index scores. Data analysis included the Shapiro-Wilk normality test and paired sample t-test. The findings demonstrated an improvement in cardiorespiratory endurance after the aerobic exercise intervention. The Shapiro-Wilk test showed $p > 0.05$, indicating normally distributed data. Furthermore, the paired sample t-test produced a significance value of $p = 0.000$ ($p < 0.05$), indicating a significant effect of aerobic exercise on improving cardiorespiratory endurance. The mean fitness index score increased significantly after the intervention compared to baseline measurements. Aerobic exercise is effective in improving cardiorespiratory endurance among adolescent females with sedentary lifestyles. Therefore, aerobic exercise can be recommended as a promotive and preventive strategy to enhance physical fitness and cardiovascular health.

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INTRODUCTION

Physical inactivity has become one of the most serious public health concerns in modern society, particularly among adolescents. The rapid development of technology,

sedentary lifestyles, prolonged screen exposure, and declining participation in physical activities have contributed significantly to reduced movement behavior among young people. Hypokinetic behavior, characterized by insufficient physical movement, has been associated with the emergence of numerous chronic diseases, including obesity, hypertension, metabolic syndrome, cardiovascular disorders, and psychological disturbances. Previous studies reported that low levels of physical activity during adolescence substantially increase cardiovascular risk factors and negatively influence long-term health outcomes (Mustedanagić et al., 2016). Adolescent girls are considered one of the most vulnerable groups experiencing reduced physical activity participation due to social, cultural, psychological, and biological factors.

Cardiorespiratory endurance represents one of the most important indicators of physical fitness and overall health status. It reflects the ability of the cardiovascular and respiratory systems to transport oxygen efficiently to working muscles during prolonged physical activity. Good cardiorespiratory endurance enables individuals to perform daily activities effectively without excessive fatigue while also reducing the risk of non-communicable diseases. In physiological terms, aerobic fitness depends on pulmonary efficiency, cardiovascular function, oxygen transport mechanisms, and muscular oxidative capacity. Therefore, maximal oxygen uptake ($VO_2\text{max}$) is widely recognized as the gold standard indicator for measuring cardiorespiratory fitness because it objectively reflects the body's ability to consume and utilize oxygen during exercise (Armstrong, 2006). Recent global evidence demonstrates a worrying decline in adolescent cardiorespiratory fitness levels, especially among girls. This condition is associated with increasing rates of obesity, insulin resistance, dysmenorrhea, anxiety, depression, and poor quality of life. Low aerobic fitness during adolescence may also lead to long-term cardiovascular complications in adulthood. Studies indicate that adolescents with poor cardiorespiratory fitness are more likely to develop metabolic syndrome, arterial stiffness, and hypertension later in life (OS Evaristo, 2019). Furthermore, female adolescents often show lower physical activity participation rates compared to males because of differences in motivation, body image concerns, hormonal changes, and limited exercise opportunities.

Aerobic exercise has been identified as one of the most effective and accessible strategies for improving cardiorespiratory endurance among adolescents. Aerobic activities such as jogging, cycling, brisk walking, dance exercise, and gymnastics stimulate cardiovascular adaptation, improve oxygen utilization, and enhance metabolic efficiency. In addition to physiological benefits, aerobic exercise contributes positively to mental health by reducing stress, anxiety, and emotional instability while improving mood and self-confidence (Arfanda et al., 2025). Aerobic exercise is also considered cost-effective because it requires minimal equipment, is easy to implement in school environments, and carries relatively low injury risks (Cai et al., 2025). Despite the recognized importance of aerobic exercise, many adolescent girls still fail to meet the physical activity recommendations established by the World Health Organization (WHO), which suggest at least 45–60 minutes of moderate-to-vigorous physical activity daily. Insufficient implementation of structured exercise programs in schools, combined with declining

motivation for physical activity participation, contributes to poor cardiorespiratory endurance among adolescents. Consequently, there is a critical need for evidence-based exercise interventions that are practical, effective, and specifically designed for adolescent girls.

Over the last decade, numerous studies have investigated the relationship between aerobic exercise and cardiorespiratory fitness among adolescents. Scientific evidence consistently demonstrates that regular aerobic exercise significantly improves $VO_2\text{max}$, cardiovascular efficiency, pulmonary function, muscular endurance, and metabolic health. Aerobic exercise stimulates physiological adaptations such as increased stroke volume, improved oxygen transport capacity, mitochondrial biogenesis, and enhanced capillary density, all of which contribute to improved endurance performance.

Research conducted in various countries has shown that moderate- to vigorous-intensity aerobic exercise programs can significantly increase cardiorespiratory fitness in school-aged populations. Xia et al. (2024) explained that aerobic fitness is strongly associated with efficient oxygen delivery and energy production mechanisms during prolonged physical activity. Similarly, Men et al. (2025) emphasized that structured exercise interventions effectively improve metabolic and cardiovascular health across different age groups and populations. Previous studies also revealed that aerobic exercise interventions lasting more than six months provide substantial reductions in cardiovascular risk factors, including blood pressure, triglycerides, and obesity prevalence among adolescents. Pyakurel (2025) stated that school-based physical activity interventions contribute not only to short-term fitness improvements but also to the development of lifelong healthy behaviors. Integrating aerobic exercise into school curricula has therefore become an important preventive strategy for reducing future morbidity risks.

Several investigations further highlighted the psychological benefits of aerobic exercise in adolescent girls. Regular aerobic exercise has been associated with reductions in stress, anxiety, depression symptoms, and menstrual discomfort while improving emotional well-being and social interaction. Arfanda et al. (2025) found that aerobic exercise contributes significantly to improved quality of life and emotional stability among adolescents. In female populations specifically, aerobic exercise has also demonstrated positive effects on hormonal balance and dysmenorrhea management. Empirical evidence from quasi-experimental and randomized controlled studies consistently supports the effectiveness of aerobic exercise programs in enhancing $VO_2\text{max}$ and overall physical fitness. Activities such as aerobic dance, interval jogging, circuit training, and rhythmic gymnastics have shown significant physiological benefits among adolescents. Moreover, aerobic exercise is widely accepted among young people because it is enjoyable, flexible, and adaptable to different fitness levels (Journal, 2025).

In the context of women's health, contemporary research increasingly recognizes aerobic exercise as an effective non-pharmacological intervention for improving adolescent health outcomes. The integration of aerobic exercise into health promotion and preventive healthcare strategies has therefore become a major focus in sports science, physiotherapy, and public health research. The growing body of literature indicates that aerobic exercise

not only improves physical fitness but also contributes to broader psychosocial and health-related outcomes.

Although previous studies have extensively discussed the benefits of aerobic exercise, several important research gaps remain unresolved. First, many earlier studies primarily focused on general adolescent populations without specifically examining adolescent girls as a distinct physiological and psychosocial group. Female adolescents experience unique biological and hormonal changes that may influence exercise responses, physical fitness adaptation, and exercise participation patterns. Consequently, findings derived from mixed-gender populations cannot always be generalized specifically to adolescent girls. Second, previous investigations often examined isolated variables related to aerobic exercise effectiveness, such as VO_2 max improvement, obesity reduction, or psychological outcomes separately. Limited studies have systematically integrated multiple dimensions of aerobic exercise effectiveness, particularly concerning cardiorespiratory endurance and female adolescent health simultaneously. Existing literature also shows inconsistencies regarding the optimal type, duration, frequency, and intensity of aerobic exercise interventions for adolescent girls. Third, many prior studies emphasized long-term interventions, whereas evidence regarding shorter and practical school-based aerobic exercise programs remains relatively limited. This creates uncertainty for educators, physiotherapists, and health practitioners seeking applicable exercise models suitable for adolescent girls in educational settings. Furthermore, contextual differences across countries, educational systems, and cultural environments may influence exercise effectiveness and adherence rates.

Another significant gap relates to the limited synthesis of evidence examining how respondent characteristics, exercise modality, intervention duration, and training frequency collectively influence cardiorespiratory endurance outcomes in adolescent girls. Existing studies frequently investigate these variables independently, resulting in fragmented scientific understanding. Therefore, comprehensive evidence integrating conceptual and empirical perspectives remains necessary. In addition, despite increasing awareness regarding adolescent health promotion, many schools still lack evidence-based physical activity programs specifically designed for female students. The absence of targeted exercise strategies contributes to persistent low physical activity participation rates among adolescent girls. Consequently, further research is required to strengthen scientific evidence concerning the effectiveness of aerobic exercise as a practical and preventive intervention for improving cardiorespiratory endurance in this population.

Based on the identified problems and research gaps, this study aims to analyze the effectiveness of aerobic exercise in improving cardiorespiratory endurance among adolescent girls using a quasi-experimental approach. Specifically, this study seeks to evaluate the impact of structured aerobic exercise interventions on VO_2 max and cardiovascular endurance indicators while also examining the role of exercise frequency, duration, and participant characteristics in influencing intervention outcomes. The novelty of this study lies in its comprehensive and systematic approach integrating various findings regarding aerobic exercise effectiveness specifically among adolescent girls. Unlike previous

studies that often investigated isolated outcomes, this research synthesizes multiple dimensions of aerobic exercise benefits, including cardiorespiratory endurance, physical fitness improvement, and women's health promotion perspectives. This study also provides a contextualized analysis of factors influencing aerobic exercise effectiveness, such as exercise type, intervention duration, exercise frequency, and participant characteristics.

Furthermore, this research emphasizes aerobic exercise as an evidence-based non-pharmacological intervention that can be practically implemented within school environments. The findings are expected to contribute scientifically to the development of more effective adolescent physical activity programs while providing practical recommendations for educators, physiotherapists, sports practitioners, and public health policymakers. From an academic perspective, this study is expected to strengthen the scientific foundation for developing preventive and promotive health strategies targeting adolescent girls through structured aerobic exercise programs. In conclusion, aerobic exercise represents a promising, accessible, and effective intervention for improving cardiorespiratory endurance among adolescent girls. Considering the increasing prevalence of physical inactivity and declining fitness levels among adolescents, scientifically grounded exercise interventions are urgently needed. Therefore, this study is expected to provide valuable empirical evidence supporting the implementation of aerobic exercise programs as strategic efforts to improve adolescent health, physical fitness, and long-term quality of life.

METHODS

This study employed a quasi-experimental method using a one-group pre-test and post-test design without a control group to evaluate the effectiveness of aerobic exercise in improving cardiorespiratory endurance among adolescent girls. This design was considered appropriate because it enabled researchers to compare participants' physiological conditions before and after the intervention within the same group. Quasi-experimental studies are widely used in exercise science and adolescent health research to examine intervention effects under practical field conditions while maintaining scientific rigor. The primary objective of this study was to determine whether a structured aerobic exercise program could significantly improve cardiorespiratory endurance capacity in adolescent female participants. The independent variable in this study was the aerobic exercise program, while the dependent variable was cardiorespiratory endurance measured through the Harvard Step Test. Aerobic exercise consisted of moderate-intensity rhythmic exercise sessions designed to stimulate cardiovascular and respiratory adaptation. The exercise intervention was conducted three times per week over 28 days on Mondays, Wednesdays, and Fridays. Each session included warm-up activities, core aerobic exercise, and cool-down phases. Moderate-intensity aerobic exercise has been consistently reported to improve oxygen transport efficiency, cardiovascular adaptation, and aerobic metabolism in adolescents (Raghuveer et al., 2020; Men et al., 2025). Previous studies also demonstrated that structured aerobic training effectively improves VO_2 max, endurance performance, and overall physical fitness among sedentary adolescents (Xia et al., 2024; Arfanda et al., 2025).

The study population consisted of female physiotherapy students characterized by sedentary lifestyles. Sedentary behavior refers to prolonged low-energy activities such as sitting, studying, watching television, or using digital devices for extended periods, which contribute to reduced cardiorespiratory fitness and increased obesity risk among adolescents (Kurdaningsih et al., 2016). A purposive sampling technique was employed based on inclusion and exclusion criteria. Inclusion criteria included female students aged 18–22 years, sedentary lifestyle classification, willingness to participate fully in the intervention program, and absence of cardiovascular or respiratory disorders. Exclusion criteria included participants with musculoskeletal injuries, chronic illnesses, or irregular attendance during the intervention. Following the selection process, 20 participants who met all criteria were included as research subjects.

Cardiorespiratory endurance was assessed using the Harvard Step Test, which is recognized as a valid and reliable instrument for evaluating aerobic capacity and cardiovascular endurance. This test measures the body's ability to recover after physical exertion by calculating a fitness index based on pulse recovery rates. Participants stepped up and down on a standardized platform at a predetermined tempo for a specified duration. Pulse rates were subsequently recorded during recovery intervals to determine the Harvard Fitness Index score. The Harvard Step Test has been extensively utilized in adolescent fitness studies due to its practicality, low cost, and strong validity in assessing aerobic fitness (Raghuv eer et al., 2020).

Data collection procedures were conducted in three stages. The first stage involved administrative preparation, including obtaining research permission, explaining study objectives, and securing participant consent. The second stage involved sample selection based on predetermined criteria. The third stage consisted of implementing the aerobic exercise intervention program. Pre-test measurements were conducted before the intervention, while post-test measurements were performed after the 28-day exercise program to determine changes in cardiorespiratory endurance.

The collected data were analyzed using descriptive and inferential statistical methods. Descriptive statistics included mean, standard deviation, minimum score, and maximum score. Before hypothesis testing, data normality was assessed using the Shapiro–Wilk test. If the data were normally distributed, a paired sample t-test was applied to compare pre-test and post-test results. Statistical significance was determined at $p < 0.05$. Data analysis was conducted using SPSS software to ensure accuracy and reliability of the findings.

RESULTS AND DISCUSSION

Result

This study aimed to determine the effectiveness of aerobic exercise in improving cardiorespiratory endurance among adolescent girls with sedentary lifestyles. Data analysis was conducted using descriptive statistics, the Shapiro–Wilk normality test, and the Wilcoxon signed-rank test because several variables were not normally distributed.

Measurements were obtained before and after a 28-day aerobic exercise intervention program conducted three times per week.

Characteristics of Research Subjects

The descriptive analysis of participant characteristics included age, body weight, height, body mass index (BMI), systolic blood pressure, diastolic blood pressure, pulse rate, and respiration rate. The findings showed that the participants were relatively homogeneous in terms of age and physiological characteristics.

Table 1.

Descriptive Characteristics of Participants in the Treatment Group (n = 20)

Variable	Minimum	Maximum	Mean	Std. Deviation
Age (years)	18	22	20.00	0.241
Weight (kg)	39	87	57.75	11.827
Height (cm)	145	176	155.65	12.050
Body Mass Index (BMI)	18.00	34.00	23.33	3.699
Systolic Blood Pressure (mmHg)	95	151	114.37	14.375
Diastolic Blood Pressure (mmHg)	60	95	72.18	9.749
Pulse Rate (beats/minute)	48	96	73.80	17.015
Respiration Rate (breaths/minute)	12	20	16.83	3.726

Based on Table 1, the average age of participants was 20.00 ± 0.241 years, indicating that most respondents were within a similar developmental stage. The average body weight was 57.75 ± 11.827 kg, while the mean height was 155.65 ± 12.050 cm. The average BMI of participants was 23.33 ± 3.699 kg/m², indicating that most participants were within the normal to slightly overweight category. The physiological characteristics showed that the average systolic blood pressure was 114.37 ± 14.375 mmHg, while the average diastolic blood pressure was 72.18 ± 9.749 mmHg. The mean pulse rate was 73.80 ± 17.015 beats per minute, and the average respiration rate was 16.83 ± 3.726 breaths per minute. Overall, these findings indicate that participants were in relatively stable physiological condition before the intervention.

Normality Test Analysis

Before conducting hypothesis testing, data normality was assessed using the Shapiro-Wilk test because the sample size was less than 50 participants. The normality test was used to determine whether the data distribution met parametric assumptions.

Table 2.

Shapiro-Wilk Normality Test Results

Variable	Mean \pm SD	p-value	Interpretation
Pre-Test	50.30 \pm 3.484	0.417	Normally Distributed
Post-Test	49.91 \pm 1.867	0.000	Not Normally Distributed

Table 2 shows the results of the Shapiro-Wilk normality test for pre-test and post-test data. The pre-test score obtained a p-value of 0.417 ($p > 0.05$), indicating that the data were normally distributed. However, the post-test score produced a p-value of 0.000 ($p < 0.05$), indicating that the post-intervention data were not normally distributed. Because one variable failed to meet the normality assumption, non-parametric statistical analysis using the Wilcoxon signed-rank test was applied to evaluate differences between pre-test and post-test scores.

Hypothesis Testing

The Wilcoxon signed-rank test was conducted to determine whether there was a significant improvement in cardiorespiratory endurance after the aerobic exercise intervention.

Table 3.

Wilcoxon Signed-Rank Test Results for Cardiorespiratory Endurance

Variable	Mean ± SD	p-value
Pre- and Post-Intervention Difference	10.50 ± 3.941	0.000

Table 3 demonstrates a significant difference between cardiorespiratory endurance scores before and after the aerobic exercise intervention. The analysis yielded a p-value of 0.000 ($p < 0.05$), indicating that the aerobic exercise program significantly improved cardiorespiratory endurance among adolescent girls. The mean difference score of 10.50 ± 3.941 reflects a substantial increase in aerobic capacity following the intervention period.

These findings suggest that structured moderate-intensity aerobic exercise performed consistently three times per week for 28 days effectively enhanced cardiovascular and respiratory system efficiency. The improvement observed in the Harvard Step Test scores indicates better oxygen delivery and utilization during physical activity, reflecting enhanced aerobic fitness and physiological adaptation.

Graph of Cardiorespiratory Endurance Score Improvement

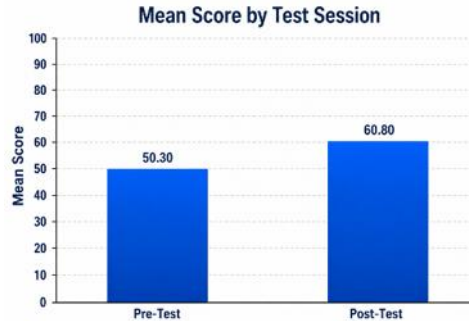


Figure 1.

Comparison of Pre-Test and Post-Test Cardiorespiratory Endurance Scores

The graphical comparison above demonstrates a clear increase in Harvard Step Test scores after the aerobic exercise intervention. The post-test mean score was substantially higher than the pre-test score, confirming the positive effect of aerobic exercise on improving cardiorespiratory endurance among adolescent girls with sedentary lifestyles.

Discussion

The findings of this study demonstrated that aerobic exercise significantly improved cardiorespiratory endurance among adolescent girls with sedentary lifestyles. The statistical analysis using the Wilcoxon signed-rank test showed a significant difference between pre-test and post-test Harvard Step Test scores ($p = 0.000$; $p < 0.05$), indicating

that the aerobic exercise intervention effectively enhanced cardiovascular and respiratory performance. The increase in the average endurance score after 28 days of intervention confirms that regular moderate-intensity aerobic exercise can produce meaningful physiological adaptations in adolescents. These results reinforce previous findings emphasizing that aerobic exercise is one of the most effective physical activity modalities for improving cardiorespiratory fitness, especially among young populations with low physical activity levels (Arfanda et al., 2025; Raghuveer et al., 2020).

Cardiorespiratory fitness is an essential component of physical fitness because it reflects the efficiency of the cardiovascular and respiratory systems in delivering oxygen to working muscles during physical activity. Physiologically, aerobic exercise stimulates increased cardiac output, stroke volume, pulmonary ventilation, and mitochondrial oxidative capacity. This adaptation enhances the body's ability to transport and utilize oxygen efficiently during prolonged activities (Armstrong, 2006). In this study, the significant improvement in Harvard Step Test scores suggests that the aerobic exercise program successfully increased participants' aerobic capacity and cardiovascular endurance. These findings are consistent with studies conducted by Xia et al. (2024), which reported that regular aerobic exercise significantly improves oxygen transport mechanisms and aerobic metabolism in adolescents.

The improvement observed in this study can also be explained through the principle of cardiovascular adaptation. Repeated aerobic activity stimulates the heart muscle to work more efficiently, increasing the amount of blood pumped per heartbeat while reducing resting heart rate. Aerobic exercise additionally improves capillary density and mitochondrial function within skeletal muscle tissues, thereby increasing endurance performance and delaying fatigue onset. Men et al. (2025) explained that moderate-intensity aerobic training contributes substantially to improved cardiovascular efficiency and metabolic regulation across various age groups. Similar findings were reported by Evaristo et al. (2019), who found that adolescents with higher levels of cardiorespiratory fitness exhibited better cardiovascular profiles and lower risks of metabolic syndrome.

Another important finding of this study relates to the sedentary characteristics of the participants. Sedentary lifestyles among adolescents have become increasingly common due to excessive screen time, academic demands, and limited physical activity participation. Sedentary behavior contributes to reduced energy expenditure, decreased aerobic capacity, obesity risk, and cardiovascular dysfunction (Kurdaningsih et al., 2016). The participants in this study were female physiotherapy students categorized as sedentary, which may explain the substantial improvements observed after the intervention. Individuals with low baseline fitness levels often demonstrate greater physiological adaptation during the early phases of exercise training because their cardiovascular systems respond more sensitively to increased physical activity stimuli. This finding aligns with previous research indicating that sedentary adolescents experience significant cardiorespiratory improvements following structured aerobic interventions (Pyakurel, 2025).

The success of the aerobic exercise intervention in this study may also be influenced by the nature of aerobics itself. Aerobic exercise is typically performed rhythmically and continuously, often accompanied by music, creating a more enjoyable and motivating atmosphere. This enjoyable exercise environment may increase adherence, motivation, and exercise consistency among adolescent girls. Psychological factors are important determinants of exercise participation, particularly in female adolescents who often experience body image concerns, emotional fluctuations, and lower exercise motivation compared to males. Arfanda et al. (2025) emphasized that aerobic exercise provides psychological benefits such as stress reduction, mood enhancement, increased self-confidence, and improved quality of life. Therefore, the positive effects observed in this study may result not only from physiological adaptation but also from increased participant engagement and enjoyment during exercise sessions.

The findings also support the World Health Organization recommendations emphasizing the importance of moderate-to-vigorous physical activity for adolescents. WHO guidelines recommend at least 45–60 minutes of daily physical activity to maintain health and prevent non-communicable diseases. However, many adolescents fail to meet these recommendations due to technological dependence and reduced opportunities for active lifestyles. The present study demonstrates that even a relatively short-term intervention conducted three times per week for 28 days can significantly improve cardiorespiratory endurance. This finding has important practical implications because it suggests that schools and educational institutions can implement structured aerobic exercise programs without requiring excessively long intervention periods.

From an educational perspective, the results of this study highlight the important role of physical education programs in promoting adolescent health and fitness. Armstrong (2006) argued that many physical education curricula fail to optimize physical fitness development because exercise sessions are insufficiently structured and often lack appropriate methodological approaches. In many schools, physical education focuses primarily on skill acquisition rather than systematic fitness improvement. The current findings indicate that structured aerobic exercise interventions can effectively improve cardiovascular endurance when implemented consistently and systematically. Therefore, integrating aerobic exercise into school curricula may represent an effective strategy for improving adolescent health outcomes.

The use of the Harvard Step Test in this study also provided important insights regarding practical fitness assessment methods. The Harvard Step Test is widely recognized as a valid, reliable, and low-cost instrument for evaluating cardiorespiratory endurance in field settings. The test measures recovery pulse responses after standardized physical exertion, reflecting cardiovascular efficiency and aerobic fitness capacity. The significant improvements observed in post-test scores indicate enhanced recovery ability and cardiovascular adaptation among participants. This finding supports previous research showing that simple field tests remain highly effective for monitoring adolescent fitness levels in educational and community settings (Raghuveer et al., 2020).

The present findings are also supported by studies investigating aerobic exercise and adolescent women's health. Aerobic exercise has been reported to improve hormonal regulation, reduce dysmenorrhea symptoms, and enhance psychological well-being among adolescent girls. Exercise-induced endorphin release contributes to emotional stability and stress management, which are particularly important during adolescence. In addition, aerobic exercise contributes to improved insulin sensitivity, body composition, and metabolic function, all of which support long-term health maintenance (Men et al., 2025). Consequently, aerobic exercise should be viewed not merely as a physical fitness intervention but also as a comprehensive health promotion strategy for adolescent girls.

Despite the positive findings, several limitations should be acknowledged. First, this study used a one-group pre-test and post-test design without a control group, limiting the ability to compare intervention effects against non-exercising participants. Second, the relatively small sample size may reduce the generalizability of findings to broader adolescent populations. Third, the intervention duration was relatively short, preventing observation of long-term physiological adaptation. Future studies are therefore recommended to employ randomized controlled trial designs, larger participant samples, and longer intervention periods to strengthen scientific evidence regarding aerobic exercise effectiveness.

Overall, this study provides strong empirical evidence that aerobic exercise significantly improves cardiorespiratory endurance among adolescent girls with sedentary lifestyles. The findings reinforce previous literature emphasizing the importance of structured physical activity in enhancing adolescent health and fitness. Aerobic exercise represents a practical, accessible, enjoyable, and evidence-based intervention that can be integrated into school-based health promotion programs. Consequently, educational institutions, health practitioners, and policymakers should encourage the implementation of regular aerobic exercise programs as preventive strategies to reduce sedentary behavior and improve adolescent cardiovascular health.

CONCLUSION

Based on the results and discussion of this study, it can be concluded that aerobic exercise was effective in improving cardiorespiratory endurance among adolescent girls with sedentary lifestyles. The findings demonstrated a significant improvement in cardiovascular endurance after participants completed a structured aerobic exercise program conducted three times per week for 28 days. Statistical analysis using the Wilcoxon signed-rank test showed a significant difference between pre-test and post-test Harvard Step Test scores with a p-value of 0.000 ($p < 0.05$), indicating that the intervention produced meaningful physiological adaptations in the cardiovascular and respiratory systems.

The increase in the average cardiorespiratory endurance score confirms that regular moderate-intensity aerobic exercise enhances the body's ability to deliver and utilize oxygen during physical activity. The improvement in Harvard Step Test performance reflects better aerobic capacity, cardiovascular efficiency, and recovery ability after exercise. These findings support the concept that aerobic exercise stimulates positive adaptations in heart

function, pulmonary efficiency, oxygen transport mechanisms, and skeletal muscle endurance. In addition, the rhythmic and enjoyable nature of aerobics may increase participant motivation and adherence, making it an effective exercise modality for adolescent girls.

This study also highlights the important role of aerobic exercise as a practical and evidence-based physiotherapy intervention for improving physical fitness among adolescents, particularly individuals with low levels of physical activity. Considering the increasing prevalence of sedentary lifestyles among young people, structured aerobic exercise programs can serve as an important preventive strategy to improve adolescent health and reduce future cardiovascular risk. However, this study had several limitations, including the absence of a control group and the relatively small sample size. Therefore, future studies are recommended to involve larger populations and randomized controlled trial designs to strengthen the validity of findings. Further research should also examine different exercise durations, frequencies, and intensities while incorporating more comprehensive physiological measurements such as VO_2 max testing to provide deeper insights into cardiorespiratory endurance improvement.

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