Original Article

Effects of Structured Aerobic Exercise on Cardiorespiratory Fitness and Flexibility in Male University Students

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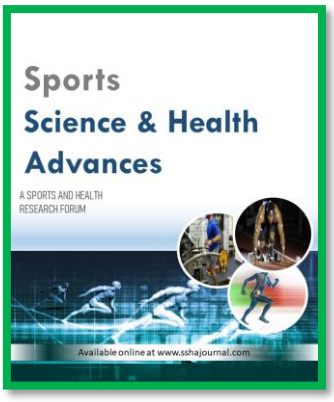

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Abstract

Purpose: This study examined the effect of 12-week aerobic training program on selected health-related physical fitness variables, specifically cardiorespiratory endurance and flexibility, among male college students. **Material and Methods**: A total of 30 male students aged 20–25 years were randomly selected and assigned into two groups: an experimental group (EG, n = 15) and a control group (CG, n = 15). The experimental group participated in a structured aerobic training program three times per week for 12 weeks, with each session lasting 60 minutes at moderate intensity, including warm-up, main exercise, and cool-down phases. The control group continued their usual physical activities without intervention. Data were analyzed using IBM SPSS Statistics Version 20. Descriptive statistics were used to summarize pre- and post-test scores, while the Shapiro–Wilk test confirmed normal distribution of the data. A paired-samples t-test was employed to examine differences between pre- and post-test performances, with the level of significance set at $p \leq 0.05$. **Results:** The findings revealed that aerobic training produced a statistically significant improvement in the experimental group's cardiorespiratory endurance and flexibility. Cardiorespiratory endurance improved markedly from a pre-test mean of approximately 1993.53 meters to a post-test mean of 2800.00 meters, while flexibility also showed significant enhancement ($p = .00$). In contrast, the control group showed no statistically significant improvement in either cardiorespiratory endurance or flexibility. **Conclusion:** The research findings highlighted regular aerobic training has a substantial positive effect on improving health-related physical fitness among male college students. Therefore, aerobic exercise can be recommended as an effective strategy for enhancing students' cardiovascular endurance and flexibility.

Keywords: Aerobic training, health-related physical fitness components, cardiorespiratory, flexibility

Introduction

Aerobic exercise is a low-intensity physical activity that primarily uses the aerobic energy- generating process to produce results Dayananda, M. (2024). Aerobic metabolism refers to using oxygen to sufficiently meet energy demands during exercise. The word "aerobic"

means "with oxygen." Exercise that necessitates the intake of significantly more oxygen than at rest is generally classified as light-to-moderate intensity exercise that can be sustained for prolonged periods of time and is adequately supported by aerobic metabolism (Nagappa & Martin, 2019). It can be done for an extended period without becoming overly tired. Regardless of whether an individual engages in intense or moderate physical activity that improves health, regular physical activity, fitness, and exercise are vital for everyone's health and wellness. Physical activity can enhance mobility and functioning even in elderly and fragile persons. Training and physical activity are crucial for establishing and maintaining cardiovascular health. Encouragement at an early age and the opportunity to do sports are therefore crucial for maintaining good health (Franklin et al.,2022). Any age group will benefit from regular aerobic exercise if the activities are tailored to the individual's fitness level and specialized. When done properly, progressive exercise raises fitness levels and enhances health. In addition, it will boost energy, foster a sense of well-being, and lower the chance of contracting numerous illnesses (Armstrong & McManus, 2010).

The physical demands of exercise exceed the demands of typical everyday activity, causing the body's systems to adapt both physiologically and physically. Several body systems must work in unison to perform any given motion. The contraction of muscles acts as a force or forceful application to the bones, creating movement at the joints. The skeletal and muscular systems work together to create movement.

Muscle contraction requires energy, which is obtained from the nourishment and oxygen provided by the digestive system. These products are transported to the muscles via the cardio-vascular system, which also eliminates waste products from metabolism such as carbon dioxide and lactic acid from the contracting muscles. In addition, the endocrine system is involved in the regulation and control of movement. Because they are biologically suited to that level, this system will manage daily tasks with efficiency (Hosiso et al., 2013).

Studies that showed that engaging in moderate physical activity is very important for the primary prevention of chronic diseases, decreasing all causes of mortality, and that exercise is one of the determinants of physical and psychological well-being (Salvo et al,. 2026). Health-Related part of physical fitness that focused on disease prevention or rehabilitation, building high functional capacity for both necessary and optional life tasks, and maintaining or improving physiological functions in biological systems that are not performance-related but are impacted by habitual activity is known as physical fitness. A person can emerge, lower their risk of illness and injury, work more productively, engage in and enjoy physical activity and look their best when they maintain an appropriate degree of health-related fitness (Thompson, 2024).

Cardiovascular endurance is a crucial indicator of general health. Cardiovascular endurance is a factor in predicting a person's quality of life, likelihood of developing an illness, and capacity to handle sudden, intense stress. Greater cardiovascular endurance in healthy persons also denotes a better level of physical fitness. Large muscular groups worked during aerobic exercise to raise heart rate. Breathing becomes deeper and faster as a result, increasing blood oxygen levels. Numerous studies demonstrate that following aerobic exercise, cardiovascular endurance increases. When aerobic exercises done correctly, the bodies cardio-respiratory system improves. The trained person's maximum oxygen consumption increases and their ability to process oxygen improves during maximum aerobic exercise, which might give their working muscles more energy. Aerobic capacity is one of the finest forms of exercise for training and preserving a healthy percentage of body fat since it is the most recognized single indicator of one's degree of cardio-respiratory fitness (Aloko et al., 2023).

Flexibility, defined as the range of motion of muscle and connective tissues at a joint or group of joints. In contrast to other, more general or systemic fitness components, flexibility is highly specific to each of the joints of the body (Balogun, 2026).

Flexibility is defined as ‘the intrinsic property of body tissues, which determines the range of motion achievable without injury at a joint or group of joints. Flexibility

determines how efficiently your muscles are. Increased flexibility has also been associated with a decreased risk of acute and chronic (overuse) injuries.

Poor flexibility can directly affect cardiovascular endurance, muscle strength, and muscular endurance. From a physiological perspective, flexibility can be attributed to both extra-muscular (joint range of motion) and intramuscular (muscle hypertonicity) causes. Muscle contraction and flexion are made possible by aerobic activity and strengthening. Stretching those muscles is also necessary to enhance joint range of motion and shield them from harm. Thus, cardiovascular exercise contributes to balance and flexibility. Appropriate daily physical activity is a major component in preventing chronic disease (Bushman, 2020).

Aerobic exercise stimulates the heart, lungs, and all working groups of muscles and produces valuable changes in the body and mind. Many physiological changes are determined by daily aerobic exercise. Generally, aerobic exercises are very important for health-related physical fitness components and skill-related physical fitness components. Regular aerobic exercises reduce the body fat percentage without causing muscle loss, as well as have an important effect on the anthropometric and hematologic levels of obese and overweight women (Park et al,. 2020).

Many studies demonstrate the importance of physical activity for the development of all components of physical fitness, but few examine the advantages of male college students engaging in aerobic exercise for the improvement of health-related physical fitness components like flexibility and cardiorespiratory endurance (Kipchirchir, 2025).

Due to a lack of aerobic exercise, most people these days suffer from chronic diseases such as diabetes, hypertension, coronary heart disease, and a few other emerging conditions. This is the outcome of a lack of awareness on the benefits of regular exercise for overall health. Physical inactivity has been linked to poor fitness and the development of chronic diseases, according to recent studies. Similarly, most college students don't get enough exercise because they put their education ahead of their physical health. That was the thinking underlying the study's site selection. This study examined the relationship between male college students' physical fitness levels and their health outcomes when engaging in aerobic exercise.

General Objectives

The general objective of this study was to evaluate the effects of aerobic training on health-related physical fitness components, specifically cardiorespiratory endurance and flexibility, in university students.

Specific Objectives

- To measure and evaluate the cardiorespiratory endurance levels of experimental group (EG) before and after the aerobic training intervention.
- To measure and evaluate the flexibility levels of experimental group (EG) before and after the aerobic training intervention.
- To measure and evaluate the cardiorespiratory endurance and flexibility levels of control group (EG) before and after 12 weeks.

Hypotheses

1. H0: There is no significant difference in pre and post test score of cardiorespiratory endurance of male college students who participated in 12-week aerobic training and for those under control group.
2. H0: There is no significant difference in pre and post test score of Flexibility for male college students who participated in 12-week aerobic training and for those under control group.

Materials and Methods

The research design employed for this study was true experimental design and pretest-posttest Control Group design or method. The researchers employed quantitative and qualitative research approach. The target population of the study consisted of male Sport Science students at Bonga University, located in Bonga, Ethiopia. From this population, 30 male students were selected through simple random sampling and voluntarily agreed to

participate in the study. Thus, the final sample size for the study was 30 participants. After selection, the participants were randomly assigned into two groups using the lottery method to ensure equal chance of group allocation and to reduce selection bias. Accordingly, 15 students were assigned to the experimental group (EG) and 15 students were assigned to the control group (CG). The experimental group participated in a 12-week training programme, while the control group continued with their usual physical activities without receiving the intervention.

To collect the required data, appropriate and standardized fitness test protocols were administered to both groups during the pretest and posttest periods. The collected data were analyzed using descriptive and inferential statistics.

Specifically, mean and standard deviation were used to summarize the data, while the paired-samples t-test was employed to determine whether there were statistically significant differences between pretest and posttest scores within groups. Data analysis was conducted using IBM SPSS Statistics version 20. Prior to inferential analysis, the normality assumption was checked, and the distribution of scores was considered normal when $p > 0.05$. Statistical significance for hypothesis testing was set at $p \leq 0.05$.

Training program

The training program was 12-week period, 3 days per week, and 60 minutes per session in a day. These 60 minutes included 10 minutes warm up and 5 minutes cool down remaining 45 minutes allowed for aerobic training program. After every week of training intensity was increased for improvement of fitness components.

Table 1. Aerobic Training plan for university male students

Treatment	Aerobic training
Frequency	3 days per week
Total duration	3 month (12 weeks)
Intensity	low -high intensity to medium intensity
Duration of session	60 minutes
Exercise day	Monday, Wednesday, and Friday
Time of training	Afternoon at 4:45--5:45 pm

Exercises: Those exercise was given to experimental groups 1 Mile run, 12-minute run, aerobic dance, jogging, fast faced walk, step ups, stretching exercises, standing to toe touch, groin stretch, arm &shoulder stretch, Sit and reach

Variables and experimental materials

The health-related fitness variables Selected for this study are cardiorespiratory endurance and flexibility. The materials used to collect primary data from study participants were stopwatch, Ruler, Tape meter, and Whistle during the training as well as the test.

Table 2. Dependent Variables and Tests tools

No.	Variables	Test	Equipment	Unit of measurement
1.	Cardiorespiratory endurance	Cooper 12-minute run test	Stopwatch, Timer,	Meter (m)
2.	Flexibility	Sit and reach	Sit & reach box, Ruler	Centimeter (cm)

The Cooper 12-minute run test requires the person being tested to run or walk as far as possible in a 12-minute period. The objective of the test is to measure the maximum distance covered by the individual during the 12-minute period. It is usually carried out on a running track by placing cones at various distances to enable measuring of the distance (Lan et al., 2022). The Cooper 12-minute run is a popular maximal running test of aerobic fitness in which participants try to cover as much distance as they can in 12 minutes.

Table 3. 12-Minute Run Fitness Test Standard Results

Age	Excellent	Above Average	Average	Below Average	Poor
Male 20-29	over 2800 m	2400-2800 m	2200-2399 m	1600-2199 m	under 1600 m

Source: Cooper Institute for Aerobics Research (2013)

Sit and reach test

The sit-and-reach test is a common measure of flexibility and specifically measures the flexibility of the lower back and hamstring muscles. This test is important because tightness in this area is implicated in lumbar lordosis, forward pelvic tilt, and lower back pain. This test was first described by (lan et al., 2022) and is now widely used as a general test of flexibility.

Procedure

This test involves sitting on the floor with legs stretched out straight ahead. Shoes should be removed. The soles of the feet are placed flat against the box. Both knees should be locked and pressed flat to the floor.

Scoring sit and reach test

The score is recorded to the nearest centimeter or half inch as the distance reached by the hand. Some test versions use the level of the feet as the zero mark, while others have the zero mark 9 inches before the feet. The table below gives you a general guide for expected scores (in cm and inches) for adults when performed without a warm-up. There is some variation in how the test is measured. In this example, the zero point is at the level of the feet (otherwise, you can add 23cm or nine inches, depending on what protocol is used). Table source: the ranges of the table is based on personal experience.

Table 4. Sit & reach Fitness Test standard Results

Status	Men (Cm)
Super	> +27
Excellent	+17 to +27
Good	+6 to +16
Average	0 to +5
Fair	-8 to -1
Poor	-20 to -9
very poor	< -20

Table 5. Descriptive Statistics of variables for Experimental group (EG)

Test tools	N	Mean (M)	(SD)
Cooper 12-minute run distance in m Pre-test	15	1993.5333	6.78093
Cooper 12-minute run distance in m Post-test	15	2800.0000	.00000
Sit & reach test in cm pre-test	15	10.3467	.76799
Sit & reach test in cm post-test	15	18.9067	.80929

Results and Discussion

The above table no 5 shows descriptive statistics of the variables (mean, standard deviation, and the number of observations). Total number of college male students whom participated in 12 week aerobic training (experimental group /EG) was 15. The average cardiorespiratory endurance test (cooper 12 minute run in meter) score before training was 1993.33m *(*M=1993.33; SD=6.78), and the average cardiorespiratory endurance test after 12 week training was 2800m (M=2800; SD=.00).

The average flexibility test (sit and reach in cm) score before training was 10.34 cm (M=10.34; SD=.76), and the average flexibility test after 12week training was 18.90cm (M=18.90; SD=.80).

Table 6. Descriptive Statistics of variables for Control group (CG)

Test tools	N	Mean (M)	Std. Deviation (SD)
Cooper 12min run CG pre-test	15	1856.6667	56.27314
Cooper 12min run CG post-test	15	1863.0000	62.41566
Sit & reach test CG pre-test	15	9.0333	3.25394
Sit & reach test CG post-test	15	9.1933	3.09896

The above table no 6 shows descriptive statistics of the variables (mean, standard deviation, and the number of observations). Total number of college male students who do not participated in 12-week aerobic training (control group / CG) was 15. The average cardiorespiratory endurance test (cooper 12-minute run in meter) pre-test score was 1856.66m (M=18.56; SD=56.27), and the average cardiorespiratory endurance test after 12 week was 1863.00m (M=18363.00; SD=62.41). The average flexibility test (sit and reach in centimeter) pre-test score was 9.03 cm (M=9.03; SD=3.25), and the average flexibility test after 12 week was 9.19 cm (M=9.19; SD=3.09).

Table 7. Paired sample T test of cardiorespiratory endurance for Experimental group (EG)

cooper 12-minute run	Mean	N	Std. Deviation	SEM	df	t
Pretest	1993.5333	15	6.78093	1.75083	14	460.620
Posttest	2800.0000	15	.00000	.00000		

Based on above table, a Paired samples t-test was conducted to determine the effect of 12-week aerobic training on cardiorespiratory endurance test score of college male student with 'cooper 12-minute run in meter'. The results indicate that, there is a significant difference between cardiorespiratory endurance test score before training (M=1993.53 with SD of =6.78) and cardiorespiratory endurance test score after training (M= 2800; SD=.000); [t(14) = .460.62, p = .00].The 95% confidence interval of the difference between the means ranged from [802.7 to 810.22] and indicate a difference between the means of the samples. We, therefore, reject null hypothesis that there is no significant difference between the means and conclude that there is an effect of 12-week aerobic training on a cardiorespiratory endurance score for EG.

Table 8. Paired sample t test of cardiorespiratory endurance for Control group (CG)

Sit & Reach	Mean	N	Std. Deviation	SEM	df	t
Pretest	1863.00	15	62.41	16.11	14	0.876
Posttest	1856.66	15	.56.27	14.52		

A paired-samples analysis was conducted to compare the Cooper 12-minute run performance of the control group (CG) before and after the intervention. The mean distance for the pre-test was 1856.67 meters (SD = 56.27), while the post-test mean increased slightly to 1863.00 meters (SD = 62.42) across 15 participants. The standard error of the mean difference was 16.12, indicating relatively low variability in the observed change. Although the post-test mean was higher, the paired-samples t-test would determine whether this difference is statistically significant, considering the 95% confidence interval of the difference. Overall, these results suggest a small improvement in the CG's Cooper run performance over the testing period.

The paired samples statistics show a clear improvement in flexibility as measured by the sit-and-reach test. Before the intervention, the participants (N = 15) had a mean pre-test score of 10.35 cm (SD = 0.77), indicating relatively low flexibility levels. After the intervention, the mean post-test score increased substantially to 18.91 cm (SD = 0.81), demonstrating a marked improvement in performance. The relatively small standard deviations and standard error means in both tests indicate that the scores were closely clustered around the mean. Moreover, the strong positive correlation between pre-test and post-test scores ($r = 0.751$, $p = 0.001$) indicates a stable and consistent association between participants' baseline and final flexibility levels, demonstrating that the observed improvement is statistically significant. The 95% confidence interval of the difference between the means ranged from [8.25 to 8.86] and indicate a difference between the means of the samples. We, therefore, reject null hypothesis that there is no significant difference between the means and conclude that there is an effect of 12 week aerobic training on a flexibility score for EG.

Conclusion

The findings indicate that 12-week aerobic training produced significant improvements in the experimental group (EG), with cardiorespiratory endurance increasing from M = 1993.53 (SD = 6.78) to M = 2800 (SD = 0.00), [$t(14) \approx 460.62$, $p = .00$], and flexibility improving from M = 10.34 (SD = 0.76) to M = 18.90 (SD = 0.80), [$t(14) = 59.43$, $p = .00$], with 95% confidence intervals of [802.7, 810.22] and [8.25, 8.86], respectively, confirming statistically significant effects; conversely, the control group (CG) showed no significant changes in cardiorespiratory endurance (M = 1863.66 to 1856.66; $t(14) = 0.876$, $p = .396$; CI [-9.17, 21.83]) or flexibility (M = 9.19 to 9.03; $t(14) = 1.90$, $p = .077$; CI [-0.019, 0.339]), leading to the conclusion that aerobic training significantly enhances health-related physical fitness variables, while lack of participation results in no measurable improvement.

Conflict of Interest

No Conflict of interest of were declared among authors.

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