

The effect of structured physical exercise on cardiovascular and respiratory physiological responses in sports science students

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Abstract

This study aims to determine the physical condition profiles of prospective taekwondo athletes at the Most human body systems, especially the cardiovascular and respiratory systems, are affected by physical activity. Understanding how exercise affects our bodies is not only theoretically important in sports science education but also crucial in real life. This study aims to analyze the effect of physical exercise on the physiological responses of the cardiovascular and respiratory systems in Sports Science students at Muhammadiyah University of Purwokerto. The physiological responses studied include heart rate, blood pressure, respiratory rate, and aerobic capacity (VO₂ max).

This research was conducted thru a quasi-experiment with a one-group pretest-posttest design. The research subjects are students from the Sports Science Study Program who meet the inclusion criteria. The intervention was conducted for 6 weeks at moderate intensity. Basic tools such as a sphygmomanometer, heart rate monitor, stopwatch, and Multistage Fitness Test are used to take measurements both before and after the intervention. Data is tested using parametric or non-parametric statistical tests based on its nature.

The research results show that resting heart rate (79.6 ± 3.1 to 71.9 ± 2.8 bpm), systolic blood pressure (125.4 ± 4.2 to 118.7 ± 3.9 mmHg), diastolic blood pressure (83.1 ± 3.5 to 77.5 ± 3.2 mmHg), and respiratory rate (20.3 ± 1.6 to 17.1 ± 1.4 x/minute) all decreased significantly. Additionally, VO₂max significantly increased to 45.1 ± 2.6 ml/kg/min from 39.2 ± 2.3 ($p < 0.05$). Sports science students experienced improved lung and respiratory function after engaging in planned physical exercise. These results confirm that programd exercise is a useful method for teaching and improving physical fitness based on sports physiology.

Keywords: Physical Exercise, Physiological Response, Sports Physiology, Cardiovascular, Respiration.

INTRODUCTION

Sport is a physical activity performed regularly and in a planned manner to improve physical and mental fitness, (Ahmad Sujiono, 2025). One of the main factors influencing how the human body functions, especially the cardiovascular and respiratory systems, is physical activity or regular exercise. Programd exercise activities can lead to positive body changes, such as increased muscle oxidative capacity, improved maximal oxygen levels, reduced resting heart rate, and increased efficiency of lung and heart function. Studies show that regular aerobic exercise increases heart capacity and cardiorespiratory fitness. Aerobic exercise also increases heart rate and the amount of oxygen used by the body, (Hamdani & Hasye, 2019). Consistent aerobic exercise improves cardiovascular capacity and cardiorespiratory fitness, with positive effects on various physiological indicators, including stroke volume and the body's maximum oxygen consumption, (Sageer & Rozario, 2024). Regular aerobic exercise has been consistently associated with improvements in cardiorespiratory fitness and cardiovascular health. A systematic review and meta-analysis of randomized controlled trials found that

exercise training significantly improves cardiorespiratory fitness and several cardiometabolic health indicators in adults (Lin et al., 2015). In addition, the magnitude of improvement in aerobic capacity may depend on exercise intensity, duration, and training volume (Crowley et al., 2022). In competitive sports, these physiological adaptations are important for Sports Science students in terms of general health and scientific learning. Planned exercise affects the cardiovascular system as a whole, including cellular energy production, blood flow distribution to active tissues, and respiratory response to increased oxygen demand during muscle activity, (Asriani et al., 2025). Regular physical exercise induces several cardiovascular adaptations that improve the efficiency of the cardiovascular system. These adaptations include improvements in cardiac function, vascular function, and cardiorespiratory fitness, which allow the body to deliver and utilize oxygen more effectively during physical activity (Isath et al., 2023). These physiological adaptations are particularly important for individuals who engage in regular aerobic exercise because they contribute to improved exercise tolerance and cardiovascular health. Literature research indicates that various exercise models can trigger adaptive responses such as higher VO₂ max, increased muscle capillary density, and overall strengthening of heart and lung function, (Tahan et al., 2025).

Understanding the body's reaction to physical exercise is very important in higher education, especially in the Sports Science Study Program at Muhammadiyah University of Purwokerto. This knowledge is important for sports practice and theoretical learning. However, to date, there is no contextual empirical data on the physiological responses of IKOR students to physical exercise. Empirical data is crucial for creating relevant teaching materials that represent the physiological characteristics of students. Additionally, the research findings systematically measuring changes in heart rate, blood pressure, respiratory rate, and estimated VO₂ max will directly enhance understanding of the body's adaptation to physical exercise from the perspective of IKOR students. These outcomes can be used as a basis for developing evidence-based sports practice guidelines that support students' ability to measure and understand physiological data. Thus, research on the influence of physical exercise on cardiovascular and respiratory physiological responses in Sports Science students at Muhammadiyah University of Purwokerto becomes crucial to fill the gap in empirical knowledge in sports physiology education and to support the development of contextual teaching materials based on research data. Based on the description, the main problem in this study is how structured physical exercise influences the physiological responses of the cardiovascular and respiratory systems in Sports Science students.

This research began with the assumption that the physiological responses of Sports Science students at Muhammadiyah University of Purwokerto are significantly influenced by physical exercise. This is based on previous research findings and theories that show planned physical exercise can alter physiological adaptations in the cardiovascular and respiratory systems. It is estimated that regular and programd physical activity has the ability to reduce resting heart rate, improve blood pressure response, and increase the efficiency of the respiratory system, as demonstrated by changes in respiratory rate. Exercise training is also recognized as an important non-pharmacological strategy for improving blood pressure. Evidence from large-scale meta-analyses of randomized controlled trials indicates that regular exercise can reduce resting systolic and diastolic blood pressure in adults (Cornelissen et al., 2013; Edwards et al., 2023). These findings suggest that systematic physical exercise may contribute not only to improvements in physical fitness but also to better cardiovascular regulation. Additionally, it is estimated that structured physical exercise can improve students' aerobic capacity, as indicated by an increase in estimated VO₂ max values. Therefore, it is hoped that structured physical exercise can help improve the cardiovascular and respiratory function of students in the Sports Science program at Muhammadiyah University of Purwokerto.

Exercise physiology studies have extensively reported on how exercise affects cardiovascular and respiratory responses. Well-designed exercise, especially aerobic exercise, has been shown to improve cardiorespiratory capacity by increasing VO₂ max, improving heart efficiency, and regulating the respiratory system. According to contemporary sports physiology research, physiological adaptations are specific to the type, intensity, and duration of exercise, so physiological responses can differ across study populations, (McArdle et al., 2014). In the national context, several studies have investigated the impact of physical exercise on students' cardiorespiratory fitness and found that exercise improves cardiovascular endurance. However, most of these studies only focus on a single fitness metric

and have not comprehensively integrated various physiological metrics into teaching materials for effective sports practice, (Rusdiana et al., 2019).

The novelty of this research lies in its focus on simultaneously investigating the cardiovascular and respiratory physiological responses of Sports Science students at Muhammadiyah University of Purwokerto using a structured physical exercise-based experimental method. Unlike previous research, the findings of this study not only focus on improving fitness but are also used as a basis for creating sports rules based on real data from students in the area. This method provides a new integrative contribution between improving the quality of practical learning in higher education and developing sports physiology science.

METHODS

A quasi-experimental method was used to address the research problem regarding the impact of physical exercise on cardiovascular and respiratory responses. This experiment was designed with pre-tests and post-tests on Sports Science students. This method allows for the analysis of physical changes before and after systematic physical exercise intervention. Exercise physiology research typically uses intervention designs to assess how variables such as heart rate, blood pressure, respiratory rate, and aerobic capacity change as a result of specific exercise programs. The training program administered to the research subjects consisted of structured physical exercises focused on physical fitness. These fitness exercises were performed at moderate intensity for 45–60 minutes per session, three times a week. The selection of exercise frequency and duration is consistent with previous research showing that repeated aerobic exercise sessions performed over several weeks can produce meaningful improvements in cardiorespiratory fitness (Mendes et al., 2013). Exercise intensity is also an important determinant of the magnitude of physiological adaptation, particularly for improvements in $VO_2\text{max}$ (Crowley et al., 2022).

The program comprised a total of 14 sessions, consisting of a pre-test followed by 12 sessions of the structured physical exercise intervention. This aligns with research findings that emphasize the importance of structured exercise for improving heart and respiratory function through measurable physiological changes, (Sihombing et al., 2024). The use of standardized tests and measurements to evaluate the components of the impact of physical exercise on cardiovascular and respiratory responses is relevant to measurable and objectively data-driven physiological research, (Ismoko & Sukoco, 2013). Pre-test and post-test measurements were conducted using standard instruments such as a heart rate monitor, sphygmomanometer, stopwatch for respiratory rate, and a multistage test for $VO_2\text{max}$ estimation. Statistical changes will be analyzed using a paired t-test to assess the significance of physiological adaptations after exercise. This approach is expected to provide strong, scientifically valid, and contextually relevant empirical evidence for the IKOR student population and support the development of evidence-based sports physiology practice manuals.

RESULTS AND DISCUSSION

The research data collected and analyzed included the results of physiological measurement tests, such as heart rate, blood pressure, respiratory rate, and $VO_2\text{max}$. These measurements were taken using standard instruments like heart rate monitors, sphygmomanometers, stopwatches, and the Multistage Fitness Test (Beep Test). Data were obtained from 40 research subjects who received structured physical treatment intervention for 6 weeks, three times a week. After the treatment ends, a final test is then conducted to determine whether there was any improvement after the treatment. The results of the descriptive analysis can be presented as follows.

Pretest and Posttest results of descriptive analysis of pretest data for resting heart rate, blood pressure, respiratory rate, and $VO_2\text{max}$.

Table 1. Frequency Distribution of Pre-Test Resting Heart Rate Data (bpm).

Interval (bpm)	Frequency	Category
70–73	4	Low
74–77	9	Normaly
78–81	15	Normaly
82–85	12	High
Total	40	

Table 2. Frequency Distribution of Post-Test Resting Heart Rate Data (bpm).

Interval (bpm)	Frequency	Category
65–68	6	Low
69–72	18	Normaly
73–76	12	Normaly
77–80	4	High
Total	40	

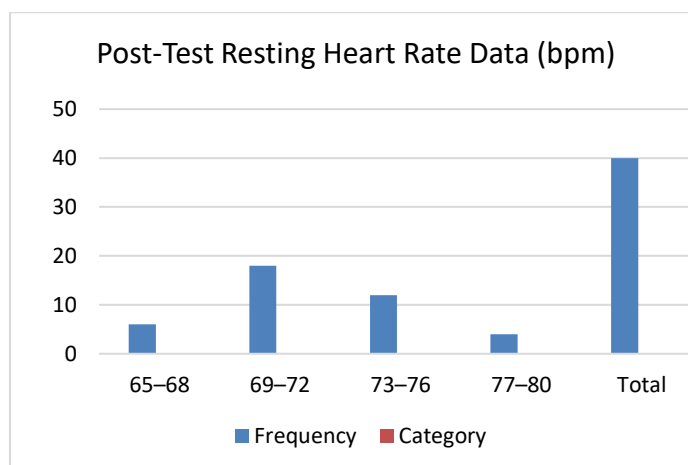
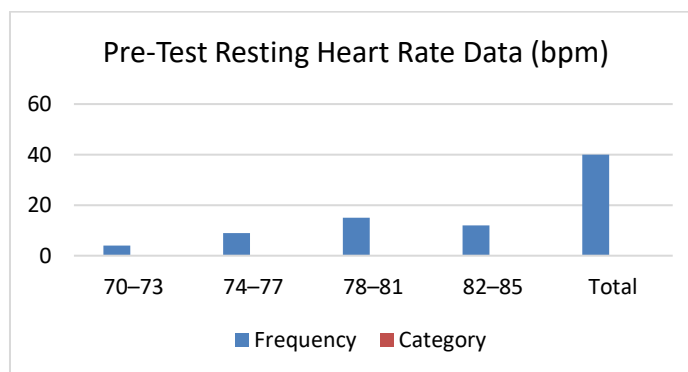


Figure 1. The following is a histogram of the pre-test and post-test group data based on frequency distribution.

Table 3. Frequency Distribution of Pre-Test Blood Pressure Data.

Interval	Frequency	Category
118–121	5	Normaly
122–125	12	Normaly
126–129	15	Pra-high
130–133	8	Pra-high
Total	40	

Table 4. Frequency Distribution of Post-Test Blood Pressure Data.

Interval	Frequency	Category
112–115	6	Normaly
116–119	18	Normaly
120–123	12	Normaly
124–127	4	Pra-high
Total	40	

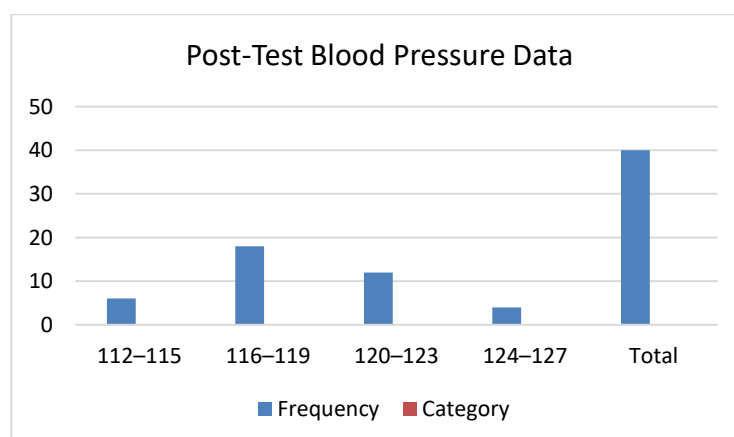
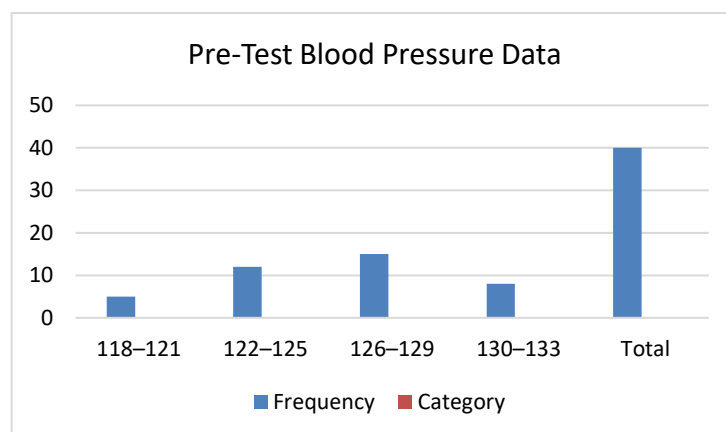


Figure 2. Histogram of Blood Pressure Data.

Table 5. Frequency Distribution of Pre-Test Data: Respiratory Rate.

Interval	Frequency	Category
17–18	6	Normaly
19–20	14	Normaly
21–22	12	High
23–24	8	High
Total	40	

Table 6. Frequency Distribution of Post-Test Data: Respiratory Rate.

Interval	Frequency	Category
17–18	6	Normaly
19–20	14	Normaly
21–22	12	High
23–24	8	High
Total	40	

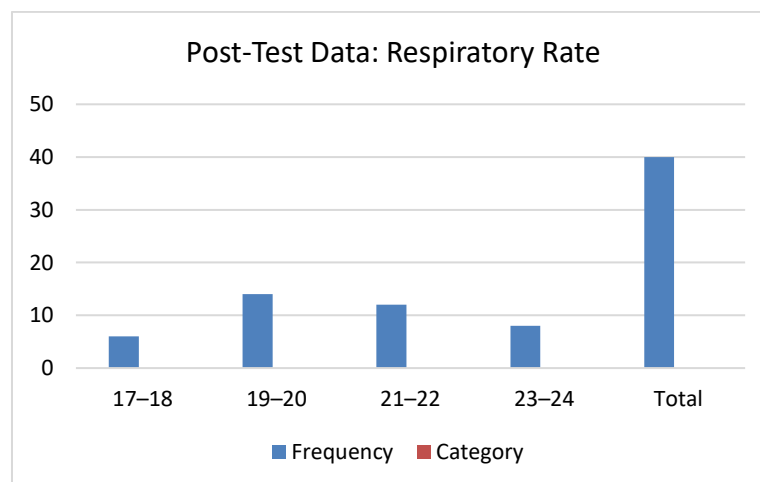
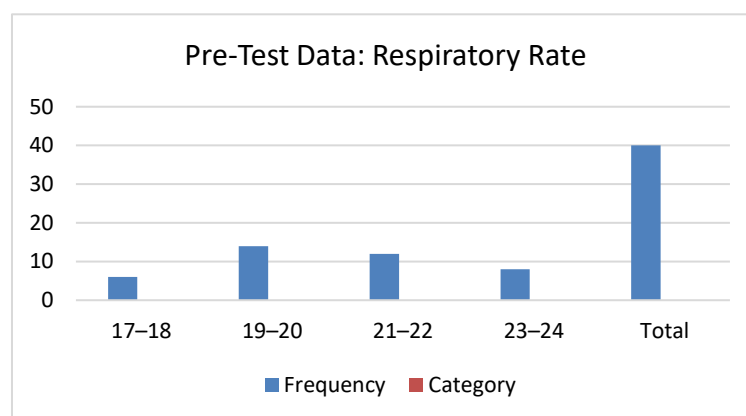


Figure 3. Histogram of Respiratory Rate Data.

Table 7. Frequency Distribution of Pre-Test Data for Vo2max.

Interval	Frequency	Fitness Category
35–37	7	Poor
38–40	18	Average
41–43	10	Good
44–46	5	Good
Total	40	

Table 8. Frequency Distribution of Post-Test Data for Vo2max.

Interval	Frequency	Fitness Category
40–42	6	Average
43–45	14	Good
46–48	15	Good
49–51	5	Very Good
Total	40	

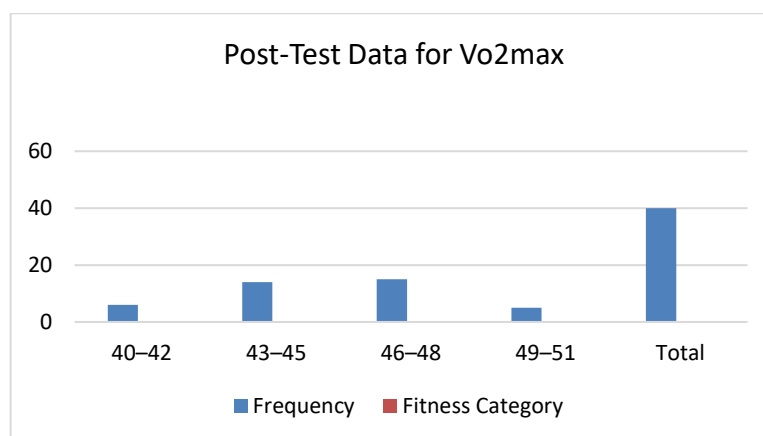
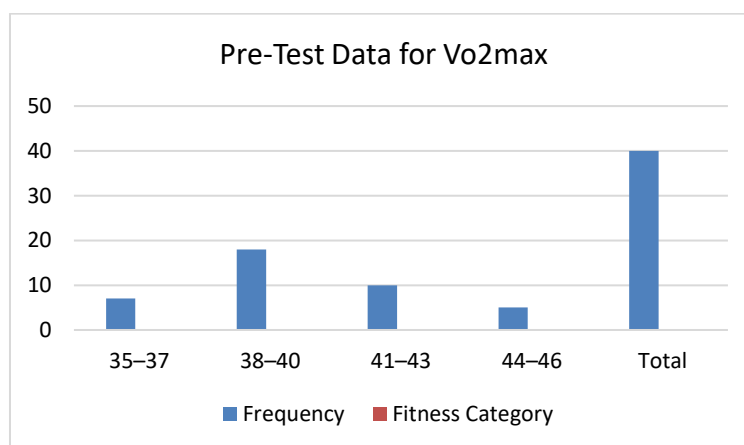


Figure 4. Histogram of VO2 max frequency data.

No	Variabel	Pretest (Mean ± SD)	Posttest (Mean ± SD)	Direction of Change
1	Resting heart rate (bpm)	79,6 ± 3,1	71,9 ± 2,8	Decrease
2	Systolic blood pressure (mmHg)	125,4 ± 4,2	118,7 ± 3,9	Decrease
3	Diastolic blood pressure (mmHg)	83,1 ± 3,5	77,5 ± 3,2	Decrease
4	Respiratory rate (x/minute)	20,3 ± 1,6	17,1 ± 1,4	Decrease
5	VO ₂ max (ml/kg/min)	39,2 ± 2,3	45,1 ± 2,6	Increase

Before data analysis is performed, prerequisite tests for data analysis will be conducted, including normality and homogeneity tests. The results of the prerequisite tests are presented below:

a. Normality Test

Normality testing uses the Kolmogorov-Smirnov test. This test will examine the hypothesis that the sample comes from a normally distributed population, accepting or rejecting the hypothesis by comparing the Asymp. Sig value with 0.05. The normality test yielded Asymp. Sig values of 0.949 for the pre-test variable and 0.774 for the post-test variable. Since the Asymp. Sig values for both variables are all greater than 0.05, the hypothesis stating that the sample is based on a normally distributed population is accepted.

b. Homogeneity test

The homogeneity test uses the F-test. This test will examine the hypothesis that the variances of these variables are equal, to accept or reject the hypothesis by comparing the calculated F value (Fhitung) with the F value from the table (Ftabel) at a significance level of $\alpha = 0.05$ and the degrees of freedom used. The calculation yielded an Fhitung value of 1.189 (>0.05). Thus, it can be concluded that the population variance is homogeneous.

c. T-Test Results

Data analysis was performed using a t-test on the pre-test and post-test group data. This test will examine the hypothesis that there is a physical fitness training program for PGSD students at UMP in 2025. To accept or reject the hypothesis by comparing the calculated t-value with the table t-value. The t-test results showed a calculated t-value of 3.923 and a table t-value at df (0.05) (39) of 2.023 with a significance level of 0.001. Since the calculated t-value is greater than the table t-value ($3.923 > 2.023$), it can be concluded that there is an effect of General Fitness Training on the Physical Fitness of PGSD UMP Students in 2025. It can be seen that the average pre-test Vo2max value is 29.19, while the average post-test Vo2max value is 31.54. The difference between the post-test and pre-test means is 2.34. From this difference in means, it can be seen that there is a percentage increase of 8.03%. The findings of the present study are consistent with those reported by Gormley et al. (2008), who demonstrated that moderate-intensity aerobic exercise can improve cardiorespiratory fitness. In their study, participants who performed exercise at an intensity of 50% VO₂ reserve for six weeks experienced an increase in VO₂max of $3.4 \text{ mL} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$, corresponding to an approximately 10.0% improvement. These findings indicate that moderate-intensity aerobic exercise can significantly improve VO₂max in healthy young adults.

CONCLUSION

The research results indicate that there is an influence of physical fitness training on the physical fitness of PGSD UMP students in 2025. The average VO₂max of 29.19 ml/kg/min indicates that many people rarely exercise, which is understandable given the demanding academic and other activities. After structured physical fitness training, the average increased to 31.54 ml/kg/minute. This means there was an increase of approximately 2.34 ml/kg/minute or 8.03%, which is a commendable step forward. Statistically, this change is not a coincidence. The paired t-test showed results of $t(39)=3.923$; $p=0.0003$. It can be concluded that the Physical Fitness Training for students does indeed bring about real changes, and the magnitude of those changes is significant for a body that was previously not accustomed to movement. The most important research message is that everyone grows at their own pace. Some people

progress quickly, others slowly, and both are equally valid. What makes the difference is consistency: little by little, it becomes a habit. Start with realistic goals, keep the intensity comfortable, give your body time to rest, and if possible, exercise in pairs or groups to encourage each other.

The obstacles we encountered were simple: student attendance was sometimes incomplete due to class schedules, the weather was sometimes uncooperative, and some participants were not feeling well. As a result, some data was delayed. The solution: we'll reschedule, standardize procedures with a short briefing, and check the equipment before the test.

Based on the finding of an 8% increase in VO_2max , we recommend that the Fitness program be maintained and enhanced with a frequency of 2–3 times per week, a duration of 30–45 minutes per session, and a gradual increase in intensity. For student involvement, use a class-friendly schedule. Include education on an active lifestyle (sufficient sleep, daily steps, hydration, nutrition) for a more sustainable impact. For further research, consider a 4 to 8-week follow-up, test replication, and controlling for confounding factors (extracurricular activities, diet) to improve the precision of effect estimates.

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