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Original Research

The Effect of Aerobic Exercise on VO2max in Physiotherapy Students at Surakarta Polytechnic

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ABSTRACT

Background: *Aerobic exercise is a physical fitness exercise that can increase VO2 max. The provision of this exercise is intended to provide exercise on the increase in aerobic physical exercise by measuring maximum oxygen consumption. An indicator of physical fitness, and heart and lung endurance is VO2max. VO2max denotes the peak amount of oxygen the body can absorb and use during vigorous exercise before reaching fatigue. The purpose of this study was to determine the effect of aerobic exercise on VO2 max in Physiotherapy as a student at Surakarta Polytechnic.*

Methods: *This research is a quasi-experimental study with a one-group pre-test and post-test design. A total of 56 students were selected using simple random sampling and received treatment with aerobic exercise in the form of 30-minute walking sessions, three times a week, for 12 sessions. Data analysis to determine the difference between pre-and post-tests was conducted using the Wilcoxon test.*

Results: *The results of this study indicate that aerobic exercise can increase VO2max in Physiotherapy students at Surakarta Polytechnic, as shown by the six-minute walking test. The hypothesis test yielded a p-value of <0.001, indicating a statistically significant difference, with a mean increase of 6.44 in VO2max values.*

Conclusion: *There is a different effect between before and after treatment given aerobic exercise can increase VO2 max in Physiotherapy students at Surakarta Polytechnic. Regular aerobic exercise is recommended to be incorporated into students' routines to improve cardiovascular endurance and support physical fitness.*

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INTRODUCTION

Fitness is the body's ability to adjust the physical load received from carrying out daily activities. Fitness is a need that needs to be met by a person in order to be able to carry out daily activities properly without experiencing disturbances (Ahmed, 2024). In improving fitness, physical exercise is a form of structured activity that involves repetitive body movements to improve physical health and fitness (Lotfi, Chakit, & Belghyti, 2024).

Based on the 2021 SDI Report by the Ministry of Youth and Sports, the fitness level of the Indonesian people is classified as very low. Of the total population, people who are categorized as unfit reach 76%. Of that figure, those who are categorized as very unfit reach 53.63%. Only 5.86% of the community has a very fit or prime condition (Mutohir et al., 2022; Permadi, Widiatmika, & Yasa, 2024).

Physical fitness is made up of five primary components body composition, aerobic capacity, muscular strength, flexibility, and speed. It acts as a crucial measure of an individual's overall physical well-being. A high level of physical fitness not only optimizes bodily functions but also contributes to better mental health, encourages social engagement, and boosts productivity in the workplace (Li et al., 2025).

Looking at the physical activities of students in the Department of Physiotherapy who every day attend lectures 5 days a week from Monday to Friday with a busy lecture schedule from 07.30–16.00, it can be seen directly that there are many activities on campus and 60% of lectures in class, which are more sitting positions (Aboshkair & Nuaimy, 2024). To improve physical fitness, it can be done with aerobic and anaerobic physical exercise. Aerobic exercise consists of low to moderate-intensity physical activities by jogging, walking, running, or cycling. While anaerobic exercise requires high intensity and short time such as sprinting or lifting weights (Christanto et al., 2023).

In this study effect of combined aerobic and resistance training exercise on VO2max and Body Mass Index (BMI) in an overweight collegiate population in a randomized controlled trial, 30 male college students aged between 18 and 26 years, with a BMI greater than 25 kg/m, were divided at random between three groups. This study highlights that combined and aerobic interventions significantly improve BMI and VO2 max, with the combined group showing the greatest BMI reduction and both combined and aerobic groups demonstrating enhanced VO2 max (Cortes et al., 2023). The research conducted on 34 students in Malang using a quasi-experimental approach with a one-group pre-test and post-test design showed an increase in maximum oxygen volume in students after being given aerobic exercise training 12 times over one month (Rahmawati & Prastowo, 2025).

This study presents a novel contribution by examining the effect of structured aerobic exercise on VO2max in physiotherapy students at Surakarta Polytechnic. These students have a high awareness of physical fitness due to their academic background, yet are often engaged in sedentary routines because of intensive lecture schedules. Unlike previous studies conducted on adolescents, the general population, or specific groups such as smokers, this research focuses on health science students who are academically equipped with knowledge of physical wellness but may not apply it in daily practice.

The study aims to bridge the gap between theoretical understanding and actual physical fitness by providing locally relevant data. Given Indonesia’s low national fitness level as reported by the Ministry of Youth and Sports (2021), the findings may contribute to the development of more targeted physical activity interventions within academics. The study aims to bridge the gap between theoretical understanding and actual physical fitness by providing locally relevant data. Given Indonesia’s low national fitness level as reported by the Ministry of Youth and Sports (2021), the findings may contribute to the development of more targeted physical activity interventions within academics.

MATERIALS AND METHOD

This research method is an experimental analytical research with a one-group pre-test post-test design model. This study provides an intervention in the form of aerobic

exercise by measuring VO2max in only one group before and after treatment implemented in March - September 2024. The subjects of Physiotherapy students at Surakarta Polytechnic class of 2024 are 56 students with random sampling who meet the inclusion criteria as follows: students of the Department of Physiotherapy class of 2024.

Exclusion criteria include: (1) students who cannot do strenuous activities (asthma, vertigo, heart disorders, etc.); and (2) students with regular sports activities. The criteria for dropping out include: (1) The subject did not participate in the exercise 3 times; and (2) not taking the post-test. In this study, the independent variable is aerobic exercise, and the dependent variable is VO2max. VO2max, defined as the maximum amount of oxygen that can be consumed during physical activity, was measured using the Six Minute Walking Test (6MWT), which records the distance traveled within six minutes.

The 6MWT was conducted by trained enumerators. Aerobic exercise in this study refers to physical activity performed at low to moderate intensity, relying on oxygen for energy production. The intervention consisted of walking for 30 minutes, three times a week, over a total of 12 sessions. This research was conducted on 56 applied physiotherapy undergraduate students in the 2nd semester of the Department of Physiotherapy at the Ministry of Health Polytechnic Surakarta from March to September 2024. The effect of the aerobic exercise intervention on VO2max was assessed using the 6MWT.

The normality test of the data in this study was conducted using the Kolmogorov-Smirnov test. The significance obtained during the pre-test was <0.001, which is less than 0.05, and the p-value during the post-test was less than 0.001, also below 0.05. This indicates that the data are not normally distributed. Therefore, because both pre-test and post-test data are abnormally distributed, the difference in means was analyzed using the Wilcoxon test. The study has been declared feasible by the Research Ethics Committee of Tk II DR Soejono Magelang Hospital under approval number 810/EC/III/2024.

RESULTS

Table 1. Distribution of characteristics of research subjects (n = 56 students)

Characteristics	n	%
Age		
≤ 20 years	55	98.21
> 20 years	1	1.78
Total	**56**	**100.00**
Gender		
Male	16	28.57
Female	40	71.42
Total	**56**	**100.00**
Body Mass Index (BMI)		
Under weight	4	7.14
Normal weight	49	87.50
Over weight	3	5.35
Total	**56**	**100.00**

Note: n = number of observations; % = percentage

Table 1 below shows the detailed distribution of the research subjects' characteristics. The characteristics of the research subjects are presented based on age,

gender, and BMI. The majority of respondents were aged ≤ 20 years, totaling 55 students (98.21%). Most of the participants were female, comprising 71.42% (40 students) of the sample. Additionally, the majority of students (87.5% or 49 students) fell within the normal BMI category.

Table 2. Changes in VO_2 max Before and After Aerobic Exercise (n = 56 students)

Variable	Min	Max	Mean ± SD	p-value*
Pre-test	21	32	26.77 ± 2.25	
Post-test	29	36	33.21 ± 1.62	**<0.001**
Difference	–	–	6.44	

Note: SD = Standar Deviation; * The Wilcoxon signed-rank test

Table 2 shows the changes in VO2max before and after aerobic exercise. VO2max was measured using the Six Minute Walking Test. The pre-test results showed a mean VO2max of 26.77 with a standard deviation of 2.25. After the intervention, the post-test mean increased to 33.21 with a standard deviation of 1.62, resulting in a mean difference of 6.44. The Wilcoxon signed-rank test produced a p-value of <0.001 ($p < 0.05$), indicating a statistically significant difference between the pre-test and post-test VO2max values.

These results confirm that aerobic exercise has a significant effect on increasing VO2max in Bachelor of Applied Physiotherapy students. In conclusion, the findings demonstrate that structured aerobic exercise can effectively improve aerobic capacity and cardiorespiratory fitness among students in the Department of Physiotherapy at the Ministry of Health Polytechnic Surakarta.

DISCUSSION

This is by previous theories. The effect of aerobic exercise is cardiopulmonary endurance. Exercise can increase oxygen uptake, increase blood capacity to transport oxygen, and lower pulse rate at rest and during activities. With aerobic exercise, cardiopulmonary endurance can increase (Muhammad et al., 2023). The amount of oxygen consumed by the body during aerobic exercise is expressed by maximum oxygen uptake or VO2max, which means the largest amount of oxygen that can be taken out of the air at the time of exercise. The higher the VO2max, the more work can be done (Fauzi et al., 2023). The acceleration of heart rate and the increase in stroke volume result in an increased cardiac output.

If this mechanism occurs continuously and programmatically, within a certain period of time the body will experience adaptation with increased cardiovascular function and lung function due to increased oxygen demand in the body increasing VO2max (Mei, Luh, & Nur, 2024). During exercise, oxygen uptake increases slowly within a few minutes and then reaches the plateau. At the end of the exercise, oxygen uptake returns to the degree before the exercise (Maaruf, Maaruf, & Rusli, 2024).

One of the parameters used to measure cardiovascular functional capacity is VO2 max. The frontmost door is the respiratory system that captures oxygen from the atmosphere, then is transported by the oxygen-carrying system to the cells, mainly by hemoglobin (Rahmawati & Prastowo, 2025). To reach the cells in the body, the cardiovascular system functions to pump blood (by the heart) and through the blood vessels that carry oxygen reach the cells.

Changes in the respiratory system, cardiovascular system, and oxygen transport system will increase VO2 capacity max (Hov et al., 2023; Parengkuan, 2021). Good physical fitness can improve several components of fitness, including muscle strength, endurance, flexibility, and body mass (Kusuma, 2019; van Baak et al., 2021). The basis of this study refers to previous research entitled "The Effect of Aerobic Exercise on Cardiorespiratory Fitness in Junior High School Students in Palembang," which found a significant change in the average cardiorespiratory fitness index after performing aerobic exercise three times a week for 15 minutes over six weeks.

The average fitness index increased from 32.74 before treatment to 41.68 after treatment ($p = <0.001$) (Tanzila et al., 2018). Another relevant study, titled "Correlation between VO2max, Weight Status, Physical Exercise, and Academic Achievement in Moroccan High School Students," involved 353 adolescents. The study reported a positive, though not statistically significant, correlation between total fitness and academic achievement ($r = 0.002$, $p = 0.49$). However, the regression prediction model was statistically significant ($p < 0.001$), accounting for approximately 25% of the variance in academic achievement ($R^2 = 0.228$, adjusted $R^2 = 0.235$) (Lotfi et al., 2024).

The limitations of the study include aerobic exercise takes quite a long time because it must be detailed for each individual. It is hoped that in the next study, it is necessary to add enumerators so that more detailed supervision can be carried out and the dose of repetition of aerobic exercise takes a longer time so that further research can take more time. The limitations of the study include aerobic exercise take quite a long time because it must be detailed for each individual. Future studies should also consider optimizing the exercise protocol and monitoring procedures to improve intervention efficiency, consistency, and reproducibility.

CONCLUSIONS

The results of this study are one of the aerobic exercise techniques to increase VO2max, it is hoped that after the administration of aerobic exercise, it can be able to increase VO2max in students of the Department of Physiotherapy of the Surakarta Polytechnic. In line with research, there is an increase in maximum oxygen volume in students after being given aerobic exercise training 12 times a month. Therefore, it is recommended that regular aerobic exercise be integrated into students' academic routines or extracurricular activities to support cardiovascular health and enhance physical performance.

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DECLARATION OF USE OF AI IN SCIENTIFIC WRITING

The authors declare that AI tools were used solely to check and improve the language of the manuscript, and the authors remain fully responsible for its final content.

CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interest.

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