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Relationship between BMI and Body Fat on VO_2Max capacity among physical education undergraduates

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Abstract

This study examines the relationship between Body Mass Index (BMI), body fat proportion, and VO_2Max capacity in Physical Education students enrolled in 2022 at FKIP Mulawarman University. The research method used a cross-sectional design. The sample amounted to 80 students through random sampling (53 males and 27 females) aged 18–22 years. BMI was calculated from weight and height using a digital scale and stadiometer, body fat proportion was measured using skinfold callipers at three points (triceps, abdomen, thighs), and VO_2Max capacity was measured with the multistage fitness test (beep test). Data analysis employed SPSS 25.0, using descriptive statistics to present the distribution of BMI, body fat proportion, VO_2Max, and Pearson product-moment correlation to assess the strength and direction of relationships between variables. The findings show a significant relationship between BMI and VO_2Max ($r = -0.45$, $p < 0.01$), while the relationship between body fat proportion and VO_2Max is stronger ($r = -0.52$, $p < 0.01$). It can be concluded that body fat proportion is a more influential factor than BMI in determining VO_2Max capacity. These results contribute to the understanding that body composition, particularly fat proportion, plays a crucial role in aerobic capacity. The contribution of this study lies in providing empirical evidence to support the development of exercise programs and curricula based on physiological profiles, which can be adapted to other educational contexts.

Keywords: BMI, body fat, VO_2Max, physical education.

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Authors contribution: a – Preparing concepts; b – Formulating methods; c – Conducting research; d – Processing results; e – Interpretation and conclusions; f - Editing the final version.

INTRODUCTION

Cardiorespiratory endurance or VO_2Max is an important component of physical fitness that plays a role in supporting heart and lung health and the body's capacity to perform physical activity on an ongoing basis. For physical education students, having good cardiorespiratory endurance is very important to support academic activities, both in the form of theory and

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physical practice. According to Usman (2023), adequate aerobic capacity enhances learning outcomes in sport-related education by improving concentration, reducing fatigue during physical tasks, and supporting overall health and academic engagement. One of the main indicators of cardiorespiratory endurance is aerobic capacity, which can be measured through VO_2Max (Lee & Zhang, 2021). VO_2Max reflects the efficiency of the cardiorespiratory system in transporting and utilizing oxygen during daily physical activities such as walking, running, and climbing stairs (Sindall, 2020). For physical education students, who generally have higher physical and academic activity demands than students in other fields, VO_2Max is an important fitness and endurance measure that supports their sports and academic performance (Redondo-Flórez et al., 2022).

Various factors can influence VO_2Max, including Body Mass Index (BMI) and body fat proportion. According to Khairunnisa et al. (2023), BMI is one of the main components of body composition that affects VO_2Max. Although BMI is commonly used to assess nutritional status by comparing weight and height, it does not distinguish between muscle and fat mass (Teresa et al., 2018). It is particularly relevant for Physical Education students whose training may increase muscle mass without significantly reducing body weight.

Maintaining optimal aerobic capacity is essential for these students, as their academic curriculum includes physical performance assessments, sports practicums, and teaching simulations that demand a high level of endurance. A high proportion of body fat can negatively affect VO_2Max by impairing oxygen transport and increasing cardiovascular strain (Afriani et al., 2021). This can lead to early fatigue during practical activities and reduce the effectiveness of physical performance.

Mondal and Mishra (2017) confirmed the relationship between body fat and VO_2Max, while Hazim et al. (2024) emphasized that structured physical activity and a healthy lifestyle are essential in maintaining ideal body composition. For Physical Education students, these efforts are

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needed to support aerobic capacity and model healthy behaviors in future roles as educators.

Maintaining a balanced body composition, particularly by maintaining a healthy proportion of body fat within a normal range, is crucial for optimizing VO_2max capacity and overall physical fitness. This is crucial for physical education students, who are expected to maintain fitness at optimal aerobic capacity to meet curriculum demands such as physical assessments, sports training, and instructional simulations. However, despite the diverse physical activity patterns and training loads involved in these courses, empirical studies specifically examining the relationship between Body Mass Index (BMI), body fat percentage, and VO_2max in this population of physical education students are limited. More targeted research is essential to understand these associations better and inform tailored fitness interventions within physical education programs.

This study aims to address this gap by analyzing the relationship between BMI, body fat proportions, and VO_2Max capacity in Physical Education students at Mulawarman University. Initial observations indicate that many students exhibit suboptimal VO_2Max scores despite regular physical activity, with some cases of elevated body fat percentages and above-normal BMI. These issues may hinder their academic performance in physically based courses and reduce their preparedness as aspiring physical educators. The significance of this study lies in its potential to generate data that can guide the formulation of targeted fitness interventions and training recommendations for physical education students. By identifying how variations in body composition affect aerobic performance, this study contributes to the development of evidence-based physical education curricula and supports students' aerobic capacity through more individualized strategies.

METHOD

This study employed a cross-sectional design, with data collected at a single point in time, to explore the relationship between Body Mass Index (BMI), body fat proportion, and VO_2Max capacity among physical education

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students in 2022 who were enrolled at FKIP Mulawarman. This design was chosen because it is suitable for observing the relationship between variables naturally without intervention or manipulation, thus enabling researchers to obtain an empirical picture of the relationship between variables based on data collected from actual conditions. The subjects of this study were 80 students (53 males and 27 females) from the Physical Education Study Program, Faculty of Teacher Training and Education (FKIP), Mulawarman University, who enrolled in 2022 and were in their second year during the 2024 data collection. Participants were selected using a simple random sampling technique, with inclusion criteria including active participation in practical courses and the absence of any known cardiovascular or metabolic health disorders. The age range of participants was 18–22 years, which reflects the typical age of second-year undergraduate students and ensures homogeneity in developmental and physiological status relevant to the variables studied.

Before, this study used a quantitative, correlational descriptive design to examine the relationship between BMI, body fat proportions, and VO_2max in Physical Education students. Before data collection, an initial briefing session was held to inform all potential participants about the study's purpose, benefits, and procedures. Students who agreed to participate voluntarily signed a written consent form. Ethics approval was obtained from the expert judgment of the Physical Education study program, Faculty of Teacher Training and Education, Mulawarman University, to ensure compliance with established research ethical standards. Data collection was conducted during regularly scheduled Physical Education learning sessions to ensure consistency of participants' physical condition and minimize the influence of external factors that could affect VO_2max results. Participants were instructed to avoid intense physical activity for at least 24 hours prior to testing and to maintain adequate hydration. The procedure was as follows: 1) Anthropometric measurements: Weight and height were measured using standard equipment, and Body Mass Index (BMI) was calculated based on these results. Body fat percentage was measured using skinfold thickness measurements performed with a calibrated skinfold calliper. 2) VO_2Max Capacity: Aerobic capacity was assessed using a multistage fitness test (beep test), which was chosen for its practicality, field applicability, and well-documented validity and reliability in evaluating aerobic endurance. 3) Data recording and analysis: All measurements were recorded immediately after testing. Data were verified and entered into a database for statistical analysis. The Pearson product-moment correlation test was used to determine the strength and direction of the relationship between variables.

This study used three main instruments to collect accurate data: Body Mass Index (BMI), body fat proportion, and VO_2Max capacity. Each of these variables was measured using standard procedures and validated tools, as described below:

a) Body Mass Index (BMI): BMI was calculated using the following standard formula:

$$BMI = \frac{\text{Body Weight (kg)}}{\text{Body Height (m)}^2} \quad (1)$$

The BMI values obtained were classified based on the categories from the World Health Organization, namely underweight, normal, overweight, and obese, to determine the nutritional status of the participants (Yusni & Meutia, 2019). Using this formula, you can calculate the BMI number, which is then classified into several categories reflecting a person's nutritional status, with body weight measured using a calibrated digital scale, and height measured using a stadiometer. The BMI value is then classified according to the standard categories of the World Health Organization (Weir & Jan, 2019) as follows:

Table 1. Categories of nutritional status based on BMI

Category	BMI (kg/m^2)
Underweight	< 18.5
Normal weight	18.5 – 24.9
Overweight	25.0 – 29.9
Obesity	30.0 – 34.9

b) Body fat proportion was measured using skinfold callipers at three points: the triceps, abdomen, and thighs. Data from the skinfold thickness was

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then calculated using a validated formula to estimate body fat percentage (Lohman & Milliken, 2019). This method is used because it is economical, easy to apply, and has an adequate level of accuracy when performed by trained measurers.

Table 2. General body fat percentage categories

Gender	Excellent	Good	Average	Poor
Male	<10%	10–14%	15–20%	>20%
Female	<17%	17–22%	23–29%	>29%

To account for physiological differences between men and women, this classification of body fat percentage was used to interpret the results separately by sex. These normative values are appropriate for young adults aged 18–22 years, which is by the characteristics of the study participants.

c) VO_2 Max capacity was measured with the multistage fitness test (MSFT). Participants ran back and forth for 20 meters following an increasingly fast sound signal. The test was stopped if the participant was unable to keep up with the speed of the signal, and the final result was used to estimate the VO_2 Max value as an indicator of aerobic capacity (Kumar, 2021).

Table 3. VO_2Max classification (ml/kg/min)

Gender	Excellent	Good	Average	Poor
Male	>60	51–60	41–50	<41
Female	>56	47–56	38–46	<38

The collected data were analyzed using SPSS (Statistical Package for the Social Sciences) version 25.0. Descriptive statistics, including mean, standard deviation, and frequency distribution, were used to describe the characteristics of the variables: Body Mass Index (BMI), body fat proportion, and VO_2Max capacity. To examine the relationships between variables, Pearson product-moment correlation analysis was conducted. In interpreting the strength of the correlation coefficients (r), this study followed the classification guidelines proposed by Akoglu (2018), which are as follows: 1) 0.00 – 0.30 = weak correlation, 2) 0.31 – 0.59 = moderate correlation, 3) ≥ 0.60 = strong correlation. This classification helped to clarify the interpretation of the correlation strength between BMI, body fat, and VO_2Max capacity across the participant group. Additionally, simple linear regression analysis was used to identify whether BMI and body fat proportion were significant predictors of VO_2Max capacity. All statistical tests were performed at a significance level of $p < 0.05$.

RESULT

1. Characteristics of Research Subjects

This study involved a total of 80 students enrolled in the 2022 Physical Education Study Program, FKIP Mulawarman University, consisting of 53 male students (66.3%) and 27 female students (33.7%). All participants were measured using the same instruments and standardized protocols for Body Mass Index (BMI), body fat proportion, and VO_2max capacity.

Table 4. Participant demographics by gender

Gender	Frequency (n)	Percentage (%)
Male	53	66.3%
Female	27	33.7%
Total	80	100%

Descriptive statistics of the participants are presented in Table 5. The mean age of the participants was 20.1 years. Average height and weight were 166.4 cm and 65.2 kg, respectively, resulting in a mean BMI of 23.7 kg/m². The average body fat proportion was 18.7%, while the mean VO_2max capacity was 42.5 ml/kg/min, indicating generally good aerobic capacity among the students.

Table 5. Descriptive statistics of main variables

Variable	Mean	SD	Min	Max
Age (years)	20.1	1.2	18	22
Height (cm)	166.4	7.5	152	183
Weight (kg)	65.2	9.4	47	88
BMI (kg/m²)	23.7	3.1	17.5	30.2
Body Fat (%)	18.7	5.6	9.2	28.4
VO_2Max (ml/kg/min)	42.5	5.9	31.2	56.3

Based on BMI classification, the distribution of nutritional status is presented in Table 5. There are 80% of students in the normal BMI category

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(18.5–24.9 kg/m²), with 10% categorized as underweight and another 10% categorized as overweight.

Table 6. Categories of nutritional status based on BMI

Category Nutritional Status	BMI (kg/m²)	Frequency	Percentage (%)
Underweight	<18,5	8	10%
Normal	18,5 – 24,9	64	80%
Overweight	≥25	8	10%
Total	-	80	100%

Table 6 below presents the distribution of body fat composition categories among students based on body fat percentage. The results show that the majority of students (35%) fall into the normal category (15–20%), followed by the normal-high category (21–24%) at 25%, and quite low (10–14%) at 22.5%. A small portion of respondents (7.5%) are classified as having very low body fat (<10%), while 10% have high body fat (≥25%). These findings suggest that the majority of students are within the healthy body fat composition range, although a small portion may be at risk of developing health problems due to excessively low or high body fat levels.

Table 7. Body fat composition categories

Body Fat Category	Range	Frequency	Percentage (%)
Low (Essential Fat)	<10	6	7.5%
Fairly Low (Athletes Fit)	10 – 14	18	22.5%
Normal (Fitness)	15 – 20	28	35%
Normal High (Average)	21 – 24	20	25%
High (Obese)	≥25	8	10%
Total	–	80	100%

Based on the VO_2max capacity measurements, the average value was 42.5 ml/kg/min, which falls into the average category. This indicates that, in general, the students had a moderate level of aerobic capacity. The distribution of VO_2Max capacity categories based on standard classification is presented in Table 8.

Table 8. Classification of VO_2Max capacity

Category	VO_2max (ml/kg/min)	Frequency	Percentage (%)
Very Poor	< 30.0	2	2.5%
Poor	30.0 – 34.9	6	7.5%
Fair	35.0 – 39.9	12	15.0%
Average	40.0 – 44.9	28	35.0%
Good	45.0 – 49.9	20	25.0%
Excellent	≥ 50.0	12	15.0%
Total	-	80	100%

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2. Relationship between BMI, Body Fat Proportion, and VO_2Max Capacity

Pearson correlation analysis showed a significant negative relationship between BMI and VO_2Max capacity ($r = -0.45$, $p < 0.01$), and between body fat proportion and VO_2Max capacity ($r = -0.52$, $p < 0.01$). These results indicate that an increase in BMI and body fat proportion is inversely proportional to VO_2Max capacity, meaning that the higher the BMI and body fat proportion, the lower a person's VO_2Max capacity. The following is a Pearson Correlation Analysis Table showing the relationship between Body Mass Index (BMI), Body Fat Proportion, and VO_2Max Capacity.

Table 9. Pearson correlation analysis between BMI, Body Fat Proportion, and VO_2max Capacity

Variable	BMI	Body Fat Proportion	VO_2max Capacity
BMI	1.00	0.68**	-0.45**
Body Fat Proportion	0.68**	1.00	-0.52**
VO_2max Capacity	-0.45**	-0.52**	1.00

The Pearson correlation coefficient (r) was used to analyze the relationship between the variables in this study. The analysis results showed that $p < 0.01$, which means that the relationship is statistically significant. The negative correlation value indicates an opposite relationship, namely, the higher the BMI or proportion of body fat, the lower the VO_2max capacity. The correlation between BMI and VO_2max capacity was found to be $r = -0.45$, which is included in the moderate correlation category, while the correlation between body fat proportion and VO_2max capacity was $r = -0.52$, which is considered stronger.

The analysis showed that BMI had a significant negative relationship with VO_2max capacity ($r = -0.45$, $p < 0.01$), indicating that the higher a person's BMI, the lower their aerobic capacity. In addition, body fat proportion showed a stronger negative relationship with VO_2Max capacity ($r = -0.52$, $p < 0.01$), indicating that body fat content has a greater influence on cardiorespiratory fitness than BMI. Meanwhile, there was a positive correlation between BMI and body fat proportion ($r = 0.68$, $p < 0.01$), meaning the higher a person's BMI, the higher their body fat proportion.

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3. Comparison of VO_2Max Capacity Based on BMI

The difference in VO_2Max capacity based on BMI has been complemented by the average proportion of body fat as follows:

Table 10. VO_2max capacity based on BMI and body fat proportion

BMI	Percentage (%)	Average VO_2max (ml/kg/min)	Body Fat Proportion (%)
Underweight	10%	45,8	12,5
Normal	80%	44,2	18,7
Overweight	10%	39,8	25,3

Table 10 presents the VO_2Max capacity based on BMI category and body fat proportion from this data. The results showed that students who were classified as underweight (10%) had the highest average VO_2Max value, which was 45.8 ml/kg/min, with an average body fat proportion of 12.5%. Students with normal BMI (80%) had a slightly lower average VO_2Max value, 44.2 ml/kg/min, and a higher average body fat proportion, 18.7%. Meanwhile, students who were classified as overweight (10%) had the lowest average VO_2Max value, which was 39.8 ml/kg/min, with the highest body fat proportion, which was 25.3%.

These findings suggest that as the body fat proportion increases, the VO_2Max capacity decreases. Although most students fall into the normal BMI category, variations in body fat percentage within each BMI group appear to affect aerobic fitness levels. This suggests that BMI and body fat proportion play an important role in determining cardiorespiratory capacity or VO_2Max.

The data presented above show that there is a statistically significant correlation between Body Mass Index (BMI), body fat proportion, and VO_2Max capacity in Physical Education students. The results of the Pearson correlation analysis are summarized in Table 11 below.

Table 11. Pearson correlation coefficient between variables

Variables	r	p-value	Interpretation
BMI and VO_2Max	-0.45	< 0.01	Moderate (negative)
Body Fat Proportion and VO_2Max	-0.52	< 0.01	Stronger (negative)

These results show that body fat proportion has a stronger negative correlation with VO_2Max capacity than BMI. This confirms that body composition, especially fat proportion, plays a more influential role in determining aerobic capacity.

Table 12. Simple linear regression analysis results

Variable	Regression Coefficient (β)	R^2 Value	*p*-value	Interpretation
Body Mass Index (BMI)	-0.38	0.202	< 0.01	Significant
Body Fat Proportion	-0.46	0.270	< 0.01	Significant

Based on the results of the simple linear regression analysis presented in Table 11, both predictor variables, BMI and body fat proportion, showed a statistically significant influence on VO_2Max capacity ($p < 0.01$). However, the body fat proportion had a higher negative regression coefficient (β = -0.46) compared to BMI (β = -0.38), and it also explained a larger portion of variance in VO_2Max (R^2 = 0.270 and 0.202). This suggests that body fat proportion predicts aerobic capacity more than BMI among Physical Education students.

The data presented above shows that there is a significant correlation between body mass index (BMI), body fat proportion, and VO_2Max capacity in Physical Education students. This finding indicates that body fat proportion has a stronger relationship to VO_2Max capacity than BMI. This confirms that body composition, especially fat proportion, plays an important role in determining students' aerobic capacity. Body fat proportion can be considered a more sensitive indicator in estimating aerobic capacity than BMI. Thus, providing a scientific basis for the development of a fitness monitoring program that is more focused on body composition to support the improvement of students' aerobic capacity.

DISCUSSION

The results of this study support the initial objective, which was to analyze the relationship between body composition and aerobic fitness among Physical Education students. These findings indicate that aerobic capacity tends to decrease as body mass and fat percentage increase. The physiological explanation for this relationship is that excess body fat increases the workload of the cardiovascular system, reduces movement efficiency, and impairs oxygen utilization during physical activity. Students in the normal BMI category (18.5–24.9 kg/m²) demonstrated better VO_2Max values (average 44.0 ml/kg/min) compared to those in the overweight category. These results confirm that maintaining a healthy body fat proportion is more critical than BMI alone in supporting cardiorespiratory endurance. The decline in VO_2Max with increasing adiposity aligns with previous research highlighting the negative impact of excess fat on cardiovascular efficiency (Fiana et al., 2023).

The results of this study indicate a significant negative relationship between body mass index (BMI), body fat proportion, and VO_2Max capacity, highlighting the critical role of body composition in influencing aerobic capacity. These findings align with previous research suggesting that excessive body fat impairs cardiovascular efficiency, particularly in oxygen transport and utilization (Bag, 2024). Excess adiposity increases the cardiovascular workload, reduces lung function, and promotes systemic inflammation, all of which can diminish aerobic capacity (Valenzuela et al., 2023).

Considering the sample in this study, physical education students at FKIP Mulawarman University, these results have particular relevance. As future sports educators and practitioners, these students are expected to maintain optimal physical fitness to meet both academic and professional demands. The negative impact of increased BMI and body fat proportion on VO_2Max underscores the importance of maintaining healthy body composition to support cardiovascular health and physical performance in this population. The observed correlations between BMI and body fat proportion with VO_2Max underscore the importance of maintaining a healthy body composition to support cardiovascular health and physical performance. This is in line with the findings of Heileson et al. (2022), who emphasized the strong role of body composition and VO_2Max as long-term predictors of cardiovascular health and quality of life.

It is important to note that BMI itself is a limited indicator of aerobic capacity, as it does not distinguish between muscle mass and fat mass (Wu et al., 2024). In contrast, body fat percentage provides a more direct and

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nuanced measure of physiological load on the cardiovascular system and accurately predicts aerobic capacity (McKee, A., 2020). Therefore, these findings suggest that fitness monitoring and intervention programs for Physical Education students should focus not only on weight loss, but more specifically on reducing body fat percentage. This targeted approach is more effective in improving VO_2Max and overall cardiorespiratory endurance (Amin et al., 2021), which are critical to maintaining future professional demands and their health (Amin et al., 2021).

Previous studies have supported the findings of this study, according to Nur Fiana & Sofiana Putri (2023), who reported that increasing body fat percentage was associated with a significant decrease in VO_2Max capacity, emphasizing the negative impact of excess body fat on aerobic performance. Similarly, Rickta et al. (2024), who found a correlation between body fat percentage and VO_2Max, also found that higher body fat levels were associated with lower aerobic capacity in students, underlining the importance of measuring body fat in assessing aerobic capacity. The proportion of body fat should be the main indicator considered in the evaluation of aerobic capacity, as it has a more significant effect on aerobic capacity than body mass index.

A high proportion of body fat can inhibit the efficiency of oxygen use during these activities because fat tissue has lower vascularization than muscle tissue. This results in limited oxygen supply to working muscles, increased cardiac workload, and ultimately decreased VO_2Max capacity (Joyner & Dominelli, 2022). This condition has an impact on the performance of students' aerobic capacity when carrying out academic physical activities such as sports practicums, learning simulations, physical fitness measurements, and various motor skills tests that require stable endurance and stamina. Low VO_2Max capacity can limit the body's ability to perform activities efficiently, increase fatigue, and reduce the effectiveness of practical learning (Goncalves et al., 2023). The study by Afshari et al. (2019) also showed that high body fat percentage and body mass index (BMI) are closely related to decreased aerobic capacity, even

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in young, physically active individuals such as students. In addition, research by Vijaykumar et al. (2019) showed that high BMI is mainly due to increased body fat, leading to reduced maximal oxygen consumption. This physiological barrier not only reduces aerobic capacity but also increases the perception of fatigue during physical activity, especially in younger populations and physically active individuals (Behrens et al., 2023).

Excess body fat can put an additional burden on cardiovascular function during physical exercise. This is because a body with higher body fat requires more energy to perform physical work than a body with lower body fat (Latifah et al., 2019). Individuals with excess body fat tend to tire more quickly and can reduce aerobic capacity (Duda et al., 2019). Research by Weeldreyer et al. (2024) showed that individuals with higher fat mass had lower aerobic capacity, regardless of their level of physical activity, indicating that fat mass acts as a limiting factor for the efficiency of body performance. Fat mass characterized by excess visceral fat conditions is associated with systemic inflammation that disrupts endothelial function and reduces oxygen delivery during physical activity (Kawai et al., 2021). The proportion of body fat plays a role in the efficiency of pulmonary ventilation during activity. Although regular physical training can increase lung capacity, excess fat mass remains a mechanical obstacle in the respiratory system (Qhuzairi et al., 2023).

Although the results of this study provide important insights into the relationship between BMI, body fat proportion, and VO_2Max capacity, several limitations need to be considered. First, this study only involved students from 2 classes in one study program, which may not represent a wider population. Second, the measurement of BMI and body fat proportion relied on methods that may be less accurate, such as measuring weight and height without considering high body fat distribution. In addition, longitudinal studies involving physical interventions may be needed to identify long-term changes in VO_2Max capacity. Therefore, the results of this study should be seen as an initial understanding of the importance of body composition to aerobic capacity, considering that further research is needed to confirm these findings in a wider population and with a more comprehensive methodology. To overcome the limitations of this study, it is recommended that future studies use more accurate body composition measurement tools. This is important because the methods used in this study, such as BMI and body fat proportion, still have limitations in describing the actual body condition.

CONCLUSION

This study concludes that both Body Mass Index (BMI) and body fat percentage are significantly related to VO_2Max capacity in Physical Education students, with body fat percentage demonstrating a stronger correlation than BMI. This indicates that adiposity exerts a greater influence on aerobic capacity, reinforcing the view that body composition is a critical determinant of physical fitness. The practical implication of these findings is that routine assessments of BMI and body fat should be integrated into student fitness evaluations to ensure more accurate monitoring of health and performance potential. Such integration would enable educators and trainers to design more effective exercise and nutritional programs tailored to the physiological profiles of students. Beyond practical applications, this research contributes to the academic discourse by providing empirical evidence on how excess body fat impairs aerobic function, thus extending current knowledge on the interplay between body composition and endurance capacity. The findings highlight the importance of addressing adiposity in the context of preparing future educators, whose physical readiness may influence their professional effectiveness and role-modeling capacity.

Furthermore, this study emphasizes the relevance of adopting evidence-based strategies that not only improve aerobic capacity but also promote long-term health outcomes among university students. Future research is encouraged to develop and test intervention models that target fat reduction and aerobic capacity enhancement, providing a foundation for longitudinal studies exploring such programs' sustained impact in educational and athletic contexts.

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11 (3) 2025| 420-438

REFERENCES

Afriani, A., Ginting, S., & Anggita, G. (2021). The Effect of Aerobic Exercise on Body Weight and Body Fat Percentage. In *ISMINA 2021: Proceedings of the 5th International Conference on Sports, Health, and Physical Education, ISMINA 2021, 28-29 April 2021, Semarang, Central Java, Indonesia* (p.194). European Alliance for Innovation. https://doi.org/10.4108/eai.28-4-2021.2312189

Afshari, D., Rami, M., Shirali, G. A., & Azadi, N. (2019). Evaluation of the Effect of Body Mass Index and Body Fat Percentage on the Maximal Oxygen Consumption: A Cross-sectional study. *Jundishapur Journal of Health Sciences*, *11*(2). https://doi.org/10.5812/jjhs.87283

Amin, N., Setiyawan, J., Priyadi, D., & Mulyo, H. (2021). The Relationship of Nutritional Status on Muscle Strength (Arm, Leg, and Abdomen) of Wrestling Athletes. In *Nutrition Research and Development Journal.* https://doi.org/10.15294/nutrizione.v1i2.52137

Bag, U. (2024). Study on Physical Fitness Index BMI and VO2Max of Physical Education Students. *International Journal of Sports Science and Physical Education*, *9*(4), 54–58. https://doi.org/10.11648/j.ijsspe.20240904.11

Behrens, M., Gube, M., Chaabene, H., Prieske, O., Zenon, A., Broscheid, K. C., & Weippert, M. (2023). Fatigue and human performance: an updated framework. *Sports Medicine*, *53*(1), 7-31. https://doi.org/10.1007/s40279-022-01748-2

Duda, K., Majerczak, J., Nieckarz, Z., Heymsfield, S. B., & Zoladz, J. A. (2019). Human body composition and muscle mass. Academic Press. In *Muscle and Exercise Physiology*, 3-26. https://doi.org/10.1016/B978-0-12-814593-7.00001-3

Fiana, D. N., Putri, M. S., Berawi, K., Wintoko, R., & Rahmayani, F. (2023). Relationship between Muscle Mass and VO_2Max in Medical Faculty Students, University of Lampung with the Balke Test Method. *Medical Journal of the University of Lampung*, *7*(2), 125–127.

Goncalves, E. C. D. A., Nardo, N., Ribas, M. C. D. S., & Silva, D. A. S. (2023). Which anthropometric equation to predict body fat percentage is more strongly associated with maximum oxygen uptake in adolescents? A cross-sectional study. *Sao Paulo Medical Journal*, *141*(6), e2022437. https://doi.org/10.1590/1516-3180.2022.0437.R1.07022023

Hazim, H., Zalmai, M. R., & Bahir, H. (2024). Exploring the Impact of Nutrition and Physical Activity on Human Metabolism. *Sprin Journal of*

Arts, Humanities and Social Sciences, *3*(4), 39–42. https://doi.org/10.55559/sjahss.v3i4.284

Heileson, J. L., Papadakis, Z., Ismaeel, A., Richardson, K. A., Torres, R., Funderburk, L., ... & Forsse, J. S. (2022). The benefits of utilizing total body composition as a predictor of cardiorespiratory fitness based on age: A pilot study. *International Journal of Environmental Research and Public Health*, *19*(9), 1–8. https://doi.org/10.3390/ijerph19095758

Joyner, M. J., & Dominelli, P. B. (2021). Central cardiovascular system limits to aerobic capacity. *Experimental Physiology*, *106*(12), 2299–2303. https://doi.org/10.1113/EP088187

Kawai, T., Autieri, M. V., & Scalia, R. (2021). Adipose tissue inflammation and metabolic dysfunction in obesity. *American Journal of Physiology-Cell Physiology*, *320*(3), C375-C391. https://doi.org/10.1152/ajpcell.00379.2020

Khairunnisa, S., Fiana, D., Ismunandar, H., & Berawi, K. (2023). The Relationship of Body Mass Index to Maximum Oxygen Volume (VO_2Max) of First-Year Medical Students at the University of Lampung. *Medical Profession Journal of Lampung, 13*(1), 28–34. https://doi.org/10.53089/medula.v13i1.610

Kumar, A. S. (2021). Validity of the 20 Meter Multistage Shuttle Run Test (MSSRT) In Predicting VO2 Max. *ACPES Journal of Physical Education, Sport, and Health (AJPESH)*, *1*(2), 131–133. https://doi.org/10.15294/ajpesh.v1i2.52587

Latifah, N., Margawati, A., & Rahadiyanti, A. (2019). The relationship between body composition and physical fitness in hockey athletes. *Journal of Sport, 7*(2), 146-154. https://doi.org/10.21831/jk.v7i2.28085

Lee, J., & Zhang, X. (2021). Is There Really A Proportional Relationship Between VO_2Max and Body Weight? A Review Article. *PLoS One, 16* (12), e0261519. https://doi.org/10.1371/journal.pone.0261519

Lohman, T., & Milliken, L. A. (2019). *ACSM's body composition assessment*. Human Kinetics. American College of Sports Medicine.

McKee, A. (2020). *Association of Various Physiological and Fitness Markers to Body Fat Percentage in Physically Inactive Adults* (Master's thesis, Northern Illinois University).

Mondal, H., & Mishra, S. P. (2017). Effect of BMI, body fat percentage and fat-free mass on maximal oxygen consumption in healthy young adults. *Journal of Clinical and Diagnostic Research*, *11* (6), CC17–CC20. https://doi.org/10.7860/JCDR/2017/25465.10039

Nur Fiana, D., & Sofiana Putri, M. (2023). The Effect of Body Fat Percentage on VO $_2$ Max In Faculty of Medicine Students at The University of Lampung. *Journal of Advance Research in Medical & Health Science*, *9*(7), 114–117. https://doi.org/10.53555/nnmhs.v9i7.1775

Qhuzairi, M. R., Magdaleni, A. R., Sulistiawati, S., Sawitri, E., & Putra, I. S. (2023). The relationship between physical activity and cardiorespiratory endurance in students of the Mulawarman University Medical Study Program. *Andalas Health Journal, 12* (2), 76–81. https://doi.org/10.25077/jka.v12i2.2169

Redondo-Flórez, L., Ramos-Campo, D. J., & Clemente-Suárez, V. J. (2022). Relationship between physical fitness and academic performance in university students. *International journal of environmental research and public health*, *19*(22), 14750. https://doi.org/10.3390/ijerph192214750

Rickta, J. F., Arafat, Y., Mukta, F. T. J., & Islam, R. (2025). Correlation between body fat percentage and aerobic capacity in various athletes: An open assessment. *Scientific Journal of Sport and Performance*, *4*(1), 85-91. https://doi.org/10.55860/XEOZ6800

Sindall, P. (2020). *Performance: Maximal Oxygen Uptake (VO2max). A Comprehensive Guide to Sports Physiology and Injury Management: an Interdisciplinary Approach*, 137. Scotland: Elsevier.

Teresa, S., Widodo, S., & Winarni, T. I. (2018). The Relationship Between Body Mass Index and Body Fat Percentage with Maximum Oxygen Volume in Young Adults. 7(2), 840–853. *Thesis*. Department of Medicine Faculty of Medicine University of Diponegoro.

Usman, H. A. (2023). *Study of Sports Science and Health*, 38. NEM Publisher.

Valenzuela, P. L., Ruilope, L. M., Santos-Lozano, A., Wilhelm, M., Kränkel, N., Fiuza-Luces, C., & Lucia, A. (2023). Exercise benefits in cardiovascular diseases: from mechanisms to clinical implementation. *European Heart Journal*, *44*(21), 1874-1889. https://doi.org/10.1093/eurheartj/ehad170

Vijaykumar, N., Vivek, P., Jadhav, S., Basavaraju, K., & Badiger, S. (2021). Influence of body fat, lean body mass, and body mass index levels on maximal oxygen consumption using submaximal exercise in young adults: An observational study. *National Journal of Physiology, Pharmacy and Pharmacology*, *11*(7), 683–687. https://doi.org/10.5455/njppp.2021.11.01042202108022021

Weeldreyer, N. R., De Guzman, J. C., Paterson, C., Allen, J. D., Gaesser, G. A., & Angadi, S. S. (2024). Cardiorespiratory fitness, body mass index, and mortality: a systematic review and meta-analysis. *British Journal of Sports Medicine, 59*(5), 339–346. https://doi.org/10.1136/bjsports-2024-108748

Weir, C. B., & Jan, A. (2019). *BMI Classification Percentile and Cut Off Points*. In: StatPearls. StatPearls Publishing, Treasure Island (FL); 2025. PMID: 31082114.

Wu, Y., Li, D., & Vermund, S. H. (2024). Advantages and Limitations of the Body Mass Index (BMI) to Assess Adult Obesity. *International Journal of Environmental Research and Public Health, 21* (6), 757. https://doi.org/10.3390/ijerph21060757

Yusni, Y., & Meutia, F. (2019). Anthropometry analysis of nutritional indicators in Indonesian adolescents. *Journal of Taibah University Medical Sciences*, *14*(5), 460-465. https://doi.org/10.1016/j.jtumed.2019.07.001

https://doi.org/10.29407/js_unpgri.v11i3.24877
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