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Original Article

The Relationship between Body Fat Percentage and Physical Fitness: A Cross-Sectional Study among Medical Students in Indonesia



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ABSTRACT

Background: Physical fitness is the ability to carry out daily and leisure activities efficiently without excessive fatigue, thereby reducing the risk of chronic diseases. However, few studies in Indonesia have explored the link between body fat percentage and physical fitness among medical students. This study aims to analyze that relationship in students of the Faculty of Medicine, Indonesian Christian University.

Methods: This observational cross-sectional study involved 57 university students selected using simple random sampling. Inclusion criteria were active medical students from the 2023 intake who were willing to participate. Exclusion criteria were students with musculoskeletal injuries or chronic diseases affecting physical performance. Body fat percentage was measured using skinfold calipers, and physical fitness was assessed using the Harvard Step Test. Data were analyzed using the Pearson correlation test. Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Indonesian Christian University.

Results: The analysis showed that the majority of students had a low physical fitness index, with 71.9% of participants having low physical fitness. A significant correlation was found between body fat percentage and physical fitness ($p = 0.015$), with increasing body fat percentage associated with decreased physical fitness.

Conclusion: Increasing body fat percentage correlates with decreasing levels of physical fitness, suggesting that higher levels of body fat in college students are likely to negatively impact their ability to perform physical activity efficiently and reduce their risk of chronic disease.

Keywords: Physical Fitness; body fat; body fat percentage.

Implications for Practice:

- Regular monitoring of body composition and targeted physical fitness programs should be integrated into clinical training to promote long-term health and performance among medical students.
- Health policy initiatives should emphasize preventive strategies addressing obesity and physical inactivity to reduce early risks of chronic diseases in young adults.
- In low- and middle-income countries, implementing cost-effective community-based fitness interventions can help maintain healthy body composition despite resource limitations



Introduction

Physical fitness is an individual's capacity to perform tasks both in their free time and in their daily lives efficiently (Sajodin 2022). Physical fitness is considered good when daily physical activities can be performed routinely and without excessive fatigue, which consequently reduces the risk of developing chronic diseases earlier. An individual's physical fitness is influenced by various factors, one of which is lifestyle. This also applies to medical students, whose busy schedules and coursework can lead to a decline in physical fitness (Adnyana, Subrata, and Pratiwi 2024). Medical students are at a greater risk of obesity because they often spend long hours studying and have little time for physical activity in their busy schedules (Ghose and Dash 2024). Physical fitness is important for supporting students' social, physical, and emotional development, as well as improving their learning process and academic performance through positive effects on attention, decision-making, academic attitudes, and cognitive aspects (Quka and Selenica 2022). Body composition is a component of fitness that is related to health (Kathleen Mahan and Escott-Stump 2008). If body fat, a component of the body, increases significantly, this condition will result in a greater physical burden and a subsequent decrease in exercise capacity. Accumulation of abdominal fat restricts waist movement, making movements such as bending forward difficult. Muscle contraction can be hampered by fat accumulation in skeletal muscle, negatively impacting endurance, flexibility, agility, speed, and other physical attributes. People with obesity typically experience decreased gas exchange and oxygen utilization, which can lead to inadequate oxygen supply and decreased endurance performance (Li et al. 2022).

Obesity results from a complex interaction between biological, environmental, genetic, and psychosocial factors that influence appetite and fat storage.⁵ Body fat is classified into two types: essential fat and storage fat. Essential fat is essential for normal physiological function and is found in small amounts in various organs and tissues, including the heart, lungs, and nervous system. Men typically have about 3% essential fat, while women have about 12%, including fat in the breasts and thighs. Managing body fat percentage can help a person achieve optimal physical condition, as the amount of fat in the body is closely related to a person's health status (Rohendi, Rustiawan, and Maryati 2020). Body fat percentage is the proportion of a person's fat mass compared to their total body mass. It describes how much of their total body weight is made up of fat, usually expressed as a percentage (%). Body fat percentage is used as an indicator of body composition and health, providing information about the amount of adipose tissue in a person's body (Gellman 2020). According to the American Council on Exercise, an acceptable body fat percentage for women is 25-31%, while more than 32% is considered obese. An acceptable body fat percentage for men is 18-24%, while more than 25% is considered obese (Shoebuddin and Daimi 2019). According to the 2018 Basic Health Research (Riskesdas), the prevalence of central obesity in the 15-24 age group was 12.6% (Riskesdas 2018). Individuals with a high body fat percentage tend to have low muscle mass, which increases the risk of chronic diseases such as heart disease, stroke, diabetes, hypertension, and cancer. Obesity is correlated with a higher risk of these conditions, including heart failure and other metabolic diseases, emphasizing the importance of efforts to reduce the incidence and prevalence of obesity.

(Niemiro, Rewane, and Algotar 2023; Prabowo, Hanif, and Tangkudung 2021).

One way to assess a person's fitness level is to use a fitness test called the Harvard Step Test (HST) (Shoebuddin and Daimi 2019). This test is an easy-to-administer physical fitness assessment that aims to measure students' physical ability or strength in performing a task that will ultimately impact their work capacity (Santoso, Gaghauna, and Raihana 2023). A 40 cm-high bench, a metronome, and a stopwatch were used in this study. Respondents were instructed to perform a series of repetitive movements on the bench, alternating between up and down movements, for five minutes, by straightening their knees and maintaining their body upright while standing on the bench for five minutes or until exhaustion. Exhaustion was defined as the subject's inability to maintain the pace of up and down steps for 15 seconds. After completing the test, respondents were instructed to sit down in a chair immediately. Respondents were asked to rest for one minute, after which their pulse was measured for 30 seconds to measure their recovery heart rate. After the test, the physical fitness index was calculated using the formula: $(100 \times \text{test duration in seconds}) / (5.5 \times \text{number of heart rate recovery times})$ (Zakiuddin, Saha, and Khalid 2016).

This study is grounded in the health-related fitness model, which posits that body composition—specifically body fat percentage—directly influences cardiovascular endurance and overall physical performance. In this framework, body fat percentage serves as the independent variable, and physical fitness level, measured through the Harvard Step Test, serves as the dependent variable. Lifestyle and activity levels act as potential confounding factors that may modify this relationship. By applying this model, our analysis directly examines how variations

in body fat percentage affect measurable physical fitness outcomes among medical students. Previous research has demonstrated a significant inverse relationship between body fat percentage and physical fitness scores across various populations (Li et al., 2022; Rohendi et al., 2020; Shoebuddin & Daimi, 2019). However, most of these studies focus on adolescents or general adult populations, with limited data on medical students, particularly in Indonesia, who may face unique lifestyle constraints that predispose them to reduced physical activity. Despite the documented associations between body fat percentage and physical fitness, there is a paucity of studies examining this relationship among Indonesian medical students, especially using objective measures such as skinfold calipers for body fat assessment and the Harvard Step Test for physical fitness. Given the high local prevalence of central obesity in young adults and the specific lifestyle demands of medical students, this gap warrants targeted investigation.

Based on the above background, this study aims to analyze the relationship between body fat percentage and physical fitness in medical students. The general objective of this study was to determine the correlation between body fat percentage and physical fitness in students of the Faculty of Medicine, Universitas Kristen Indonesia, Class of 2023.

Methods

Study Design

This study uses an observational research method with a cross-sectional study approach.

Participants

This observational cross-sectional study was conducted in Jakarta, Indonesia. The inclusion criteria were active medical students from the 2023 intake who were

willing to participate, while the exclusion criteria included students with musculoskeletal injuries or chronic diseases that could affect physical performance. A total of 57 respondents were selected using simple random sampling, with the sample size determined based on the minimum requirement for correlation analysis, assuming a medium effect size, 80% statistical power, and a 5% significance level.

Instruments

Two main instruments were used in this study to measure the variables: 1) skinfold calipers for body fat percentage, and 2) the Harvard Step Test for physical fitness. Body fat percentage was measured using skinfold calipers, applying the Jackson-Pollock 3-site formula adapted for the Indonesian population (development/adaptation). The measurement method had established validity and reliability, with intraclass correlation coefficients (ICC) > 0.90 in previous studies. Physical fitness was assessed using the Harvard Step Test, a standardized and validated tool with a test-retest reliability of $r > 0.85$. The Harvard Step Test score was calculated based on the recovery pulse rate. Results were categorized into Excellent, Good, Average, Below Average, and Poor (scoring and categories) according to normative values.

Data Collection

Data collection was conducted using primary data from observations of students from the Faculty of Medicine, Indonesian Christian University, intake of 2023. Researchers selected the data according to the established inclusion and exclusion criteria, resulting in the data used in this study.

Data Analysis

Univariate analysis was performed to describe and analyze each variable. Bivariate analysis was used to determine the relationship between body fat percentage and physical fitness using SPSS 26 version with the Chi-square test. A P value <0.0001 was considered highly significant, a P value <0.05 was considered significant, and a P value >0.05 was considered insignificant.

Ethical Considerations

Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Indonesian Christian University, prior to the commencement of data collection. All participants were provided with clear verbal and written explanations about the purpose, objectives, methods, potential risks, and benefits of the research. Participation was entirely voluntary, and written informed consent was obtained from each participant before any measurement was conducted. To protect confidentiality, all data were coded without using participants' names, and only the principal investigator had access to the code list. Data were stored securely and used solely for research purposes. Participants were informed of their right to withdraw from the study at any time without any academic or personal consequences.

Results

With a sample size of 57 participants calculated using the Slovin formula, the participants met the inclusion criteria and did not fall under the study's exclusion criteria. The study results will be described through univariate and bivariate analysis.

Table 1 presents data on respondent characteristics. Of the 57 participants, four were 18-year-old students (7%), 36 were 19-year-old students (63.2%), 16 were 20-year-old students (28.1%), and one was a

21-year-old student (1.8%). There were 22 male participants (38.6%), and 35 female participants (61.4%). 41 students (71.9%) had a Physical Fitness Index (PFI) of poor, 12 students (21.1%), and 4 students (7%) had a Good PFI. The body fat percentage of participants was 8 (14%) in the fit category, 36 (63.2%) in the normal category, and 13 (22.8%) in the Obesity.

Table 1. Demographic Characteristics of Respondents

No	Characteristic	Frequency	Percentage
Age			
1	18 years	4	7
2	19 years	36	63.2
3	20 years	16	28.1
4	21 years	1	1.8
Gender			
1	Male	22	38.6
2	Female	35	61.4

Table 2. Knowledge, Attitude, and Behavior of Participants

No	Category	Frequency	Percentage
A Physical Fitness Index			
1	Poor	41	71.9
2	Moderate	12	21.1
2	Good	4	7
B Body Fat Percentage			
1	Essential Fats	0	0
2	Athletes	0	0
3	Fit	8	14
4	Normal	36	63.2
5	Obesity	13	22.8
C Frequency Distribution of Exercise Habits			
1	Routine	18	31.6
2	Not Routine	39	68.4
D Distribution of Exercise Frequency in a Week			
1	Never	13	22.8
2	1-2 times	36	63.2
3	3-4 times	5	8.8
4	5 times or more	3	5.3
E Frequency Distribution of Exercise Duration			
1	< 15 minutes	13	22.8
2	15 – 30 minutes	24	42.1
3	30 – 60 minutes	14	24.6
4	> 60 minutes	6	10.5
F Frequency Distribution of Sports Types			
1	Aerobic Activities	38	66.7
2	Anaerobic Activities	13	22.8
3	Others	6	10.5

Table 3. Results Of A Bivariate Analysis To Determine The Relationship Between Body Fat Percentage And Physical Fitness; Distribution Of Physical Fitness Index Based On Exercise Habits; Distribution Of Body Fat Percentage Based On Exercise Habits

Category	Physical Fitness Index			Total	P-Value
	Not enough	Currently	Good		
Relationship between Body Fat Percentage and Physical Fitness					
Fit	2	4	2	8	0.015
Normal	27	7	2	36	
Obesity	12	1	0	13	
Distribution of Physical Fitness Index Based on Exercise Habits					
Routine	10	5	3	18	
Not Routine	31	7	1	39	
Body Fat Percentage Distribution Based on Exercise Habits					
Routine	4	10	4	18	
Not Routine	4	20	9	33	

Discussion

Univariate analysis based on the distribution of age, gender, physical fitness index, and body fat percentage yielded a total of 57 participants who met the study inclusion criteria. These included four students (7%) aged 18, 36 students (63.2%) aged 19, 16 students (28.1%) aged 20, and 1 student (1.8%) aged 21. Based on these data, it can be concluded that the majority of participants were 19 years old. In this study, 35 students (61.4%) were female, while 22 students (38.6%) were male. The characteristics of the participants in this study were similar to a previous study conducted by Renjit et al. in 2023, although the subjects were different. The participants in that study came from a physiology department in India and had a larger sample size (Renjit et al. 2023). The results of the physical fitness index showed that the majority of students, 41 (71.9%), had a low PFI, 12 (21.1%) had a moderate PFI, and 4 (7%) had a good PFI. This indicates that, on average, students in the Faculty of Medicine, Universitas Kristen Indonesia Class of 2023 have low physical fitness. Body fat percentage was divided into five categories according to the American Council on Exercise: essential fat, athlete, fit, normal, and obese. No students fell into the essential

fat or athlete categories. Eight students (14%), nine were in the fit category, 36 students (63.2%) were in the normal category, and 13 students (22.8%) were obese. This indicates that, on average, students in the Faculty of Medicine, Universitas Kristen Indonesia Class of 2023 have a normal body fat percentage.

Physical fitness can be defined as the ability to carry out daily activities with vigor and attention, without feeling unduly tired, and with sufficient energy to enjoy leisure time and cope with emergencies. This study was conducted to assess the level of physical fitness among medical students and its relationship to body fat percentage. Of the eight students with a healthy body fat percentage, two had a low BMI, four had a moderate BMI, and two had a good BMI. The 36 students with a normal body fat percentage consisted of 27 with a low BMI, seven with a moderate BMI, and two with a good BMI. Thirteen students were classified as obese, with 12 having a low BMI and one having a moderate BMI. Bivariate analysis using Pearson Chi-Square showed a relationship between body fat percentage and physical fitness, with a p-value of 0.015.

This significant finding aligns with research conducted by Yadav, which showed that body fat percentage was associated with BMI ($p=0.00$) (Yadav et al.

2020). Research by Renjit et al. in 2023 and Miftachurochmah et al. in 2024 also reached the same conclusion, namely a relationship between body fat percentage and physical fitness ($p < 0.01$ and $p = 0.00$). 18,20 The results of the three previous studies showed a negative correlation ($r = -0.16$; $r = -0.562$; $r = -0.760$), which means statistically that an increase in body fat percentage will result in a decrease in physical fitness levels (Miftachurochmah et al. 2024; Yadav et al. 2020).

The sample in this study consisted of medical students who may experience higher levels of stress, especially at the beginning of their studies due to changes in study methods and different exams. It is assumed that medical students have a better understanding of a healthy lifestyle and good diet than students from other majors. There is no evidence to support the application of this understanding in daily practice to maintain their health. The results of this study found 13 students with obese body fat percentages, 12 of whom had low PFI.

This is consistent with research conducted by Krisdinamurtirin, which showed that the higher the body fat percentage, the lower the level of physical fitness as measured by the HST score (Krisdinamurtirin et al. 1993). Research conducted by Effendy et al showed different results, finding no relationship between body fat percentage and physical fitness ($p = 0.419$; 95% CI = 0.66-2.689) (Effendy et al. 2018). Several factors that may have contributed to this insignificant result include age differences, the measurement method used, and the characteristics of the study, which involved a larger sample size with a majority of women. Body fat percentage can decrease when physical activity is performed at a high intensity. In uncomfortable conditions, women often eat more after exercise to replace used energy, so they don't actually experience a decrease

in body fat even with intense exercise (Effendy et al. 2018).

The distribution of BMI based on exercise habits shows that the majority of students who don't exercise regularly have a low BMI. The percentage of body fat based on exercise habits shows that students who exercise regularly tend to have a better body fat percentage because they are more likely to fall into the normal and fit category compared to students who don't exercise regularly. Consistent with the literature showing a positive relationship between physical fitness and physical activity, and a negative relationship with being overweight, it can be concluded that increased physical exercise contributes to improved physical fitness (Renjit et al. 2023). Physical inactivity, overweight, and obesity are major risk factors for death globally, along with high blood pressure, smoking, and high blood sugar levels. Unhealthy habits formed early in college life often persist into adulthood. During college, students often struggle to maintain a healthy lifestyle due to the demands of studying or time constraints. Stress from studying, constant exam pressure, living away from home, and a lack of access, time, and motivation for physical activity contribute to medical students becoming overweight and obese (Yadav et al. 2020).

This study shows a significant correlation between body fat percentage and physical fitness. This is consistent with the theory that five main components of fitness are related to health: morphological, muscular, motor, cardiovascular, and metabolic. The morphological component encompasses body composition, including body fat percentage (Gellman 2020). A lower body fat percentage can improve aerobic capacity and cardiovascular endurance. and overall physical performance, thus emphasizing the importance of maintaining optimal body composition for each individual (Rickta et

al. 2025). Muscle components include power, strength, and endurance. Skeletal muscle accounts for approximately 40% of total human body weight and decreases by 3–10% each decade, starting at approximately age 25. Skeletal muscle mass plays a crucial role in overall body function. Maintaining muscle mass is crucial for maintaining strength and physical ability, especially since muscle tends to decline with age. Motor components include agility, balance, coordination, and speed of movement (Strasser and Burtcher 2018). Developing better motor skills allows a person to be more active in various physical activities. Motor skills provide the foundation for developing the movements necessary to build muscle strength and endurance, as well as cardio endurance. This is an important foundation for achieving and maintaining optimal physical fitness.

Cardiorespiratory fitness includes the ability to perform physical activity at submaximal levels, maximal aerobic power capacity, heart function, lung function, and blood pressure. Good cardiorespiratory fitness means the cardiovascular and respiratory systems are able to distribute oxygen to skeletal muscle mitochondria to produce energy during physical activity. Low cardiorespiratory fitness is a strong predictor of cardiovascular disease and mortality in adults. 26 Another major contributing factor to the increasing mortality rate from cardiovascular disease is obesity. The risk of death from cardiovascular disease is up to threefold higher in obese individuals compared to those at a healthy weight. Individuals with obesity exhibit a lower VO₂max, or aerobic power capacity, than individuals of normal weight, and for every 15% increase in VO₂max from baseline, there is a 1.4 kg decrease in fat mass over four years.

Based on this, maintaining a healthy body fat percentage reduces the risk of

cardiovascular disease and premature death. Metabolic components include glucose tolerance, insulin sensitivity, and fat and lipoprotein metabolism. Exercise reduces the risk of chronic metabolic diseases, such as type 2 diabetes, by improving insulin sensitivity and metabolism. Regular physical exercise improves beta cell function, allowing muscles, adipose tissue, and the liver to absorb more glucose from the blood, and body tissues become more sensitive to insulin. Exercise also produces positive changes in body composition and fat levels, thereby improving fat and lipoprotein metabolism. These metabolic factors collectively contribute to improved physical fitness (Belanger, Rao, and Robbins 2022). The results of this study are not always consistent with other studies. Understanding the relationship between body fat percentage and physical fitness requires further, more comprehensive study.

Implications and limitations

The findings of this study contribute to the growing body of evidence linking body composition, particularly body fat percentage, to physical fitness, thereby reinforcing theoretical models that integrate morphological and metabolic components as determinants of overall health performance. This study provides empirical support for the negative association between excess adiposity and reduced physical fitness, highlighting the importance of maintaining optimal body composition within the conceptual framework of health-related fitness. Scientifically, the results strengthen the understanding that body fat percentage serves not only as a physical measure but also as a physiological indicator of cardiovascular and metabolic efficiency. However, this study has several limitations, including its cross-sectional design, which

restricts causal inference, the relatively small and homogeneous sample limited to one institution, and the potential influence of unmeasured variables such as dietary habits, stress levels, and physical activity outside formal assessments

Relevance to Practice

The findings of this study can be applied directly in nursing and public health practice by promoting regular physical fitness assessments and body composition monitoring among students and young adults to prevent early health deterioration. Health professionals should integrate simple, low-cost interventions—such as structured physical activity programs, health education on balanced nutrition, and stress management—into campus or community health initiatives. Educational institutions and policymakers in low- and middle-income countries (LMICs) are encouraged to implement sustainable wellness programs that utilize available resources, including peer-led exercise groups and periodic health screenings, to foster a culture of healthy living and reduce long-term risks of obesity and chronic disease in resource-limited settings.

Conclusion

This study demonstrates a significant negative relationship between body fat percentage and physical fitness among medical students, indicating that higher levels of body fat are associated with lower physical fitness. These findings emphasize the importance of maintaining an optimal body composition to support overall health, endurance, and performance, particularly in populations experiencing high academic stress such as medical students. The study highlights the need for greater awareness and lifestyle modification to prevent early decline in physical fitness and related health risks, reinforcing that maintaining a healthy balance between body composition and

physical activity is essential for long-term well-being.

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CrediT Authorship Contributions Statement

Frisca Ronauli Batubara: Conceptualization, Methodology, Supervision, Writing – Original Draft
Wendy Hendrika: Software, Validation, Formal Analysis, Writing – Review & Editing
Shela A. Prameswari: Investigation, Resources, Data Curation, Project Administration

Conflicts of Interest

There is no conflict of interest.

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