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The Relationship between Body Fat Percentage and Physical Fitness

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The Relationship between Body Fat Percentage and Physical Fitness

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Abstract

Background: Physical fitness is an individual's capacity to perform tasks efficiently, both in leisure time and in daily life. Physical fitness is considered good if daily physical activities can be performed routinely and without excessive fatigue, which, as a consequence, reduces the risk of developing chronic diseases early. **Objective**: This study aims to analyze the relationship between body fat percentage and physical fitness in students of the Faculty of Medicine, Indonesian Christian University, intake of 2023. **Methods**: This study was an observational cross-sectional study, involving 57 university students. Data were collected by measuring body fat percentage using skinfold calipers, and physical fitness was measured using the Harvard Step Test. **Results**: The analysis results 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.

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 et al., 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 & 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 & Selenica, 2022). Body composition is a component of fitness that is related to health (Kathleen Mahan & 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 et al., 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 & 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 et al., 2023; Prabowo et al., 2021).

One way to assess a person's fitness level is to use a fitness test called the Harvard Step Test (HST) (Shoebuddin & 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 et al., 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 x test duration in seconds) / (5.5 x number of heart rate recovery times) (Zakiuddin et al., 2016).

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.

Research Location and Timeline

The research was conducted at the Faculty of Medicine, Christian University of Indonesia. Data collection, processing, and implementation were conducted from September 2024 to February 2025.

Participants

The population of this study was active students from the Faculty of Medicine, Universitas Kristen Indonesia, class of 2023. Using random sampling using the Slovin formula, a sample of 57 participants met the inclusion and exclusion criteria.

Data Collection & Data Analysis

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.

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 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.

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%), and 18 (22.8%) in the normal category.

Table 1. Characteristics of Respondent

Characteristic	Frequency	Percentage
Age		
18 years	4	7
19 years	36	63.2
20 years	16	28.1
21 years	1	1.8
Gender		
Male	22	38.6
Female	35	61.4

Physical Fitness Index		
Poor	41	71.9
Moderate	12	21.1
Good	4	7
Body Fat Percentage		
Essential Fats	0	0
Athletes	0	0
Fitness	8	14
Normal	36	63.2
Obesity	13	22.8

Table 2 presents data on the frequency of exercise activities undertaken by respondents. The data shows that 39 students (68.4%) did not exercise regularly, while 18 students (31.6%) exercised regularly. Thirteen students (22.8%) never exercised per week, 36 students (63.2%) exercised once or twice a week, five students (8.8%) exercised three to four times a week, and three students (5.3%) exercised five or more times a week. Thirteen students (22.8%) exercised for less than 15 minutes, 24 students (42.1%) exercised for 15-30 minutes, 14 students (24.6%) exercised for 30-60 minutes, and six students (10.5%) exercised for more than 60 minutes. Aerobic exercise was the most common type of exercise among students, with 38 students (66.7%) participating. Meanwhile, 13 students (22.8%) participated in non-aerobic exercise, and 6 students (10.5%) participated in other types of exercise.

Table 2. Frequency Distribution of Sports Activities

Cathegory	Frequency	Percentage
Frequency Distribution of Exercise Habits		
Routine	18	31.6
Not Routine	39	68.4
Distribution of Exercise Frequency in a Week		
Never	13	22.8
1-2 times	36	63.2
3-4 times	5	8.8
5 times or more	3	5.3
Frequency Distribution of Exercise Duration		
< 15 minutes	13	22.8
15 – 30 minutes	24	42.1
30 – 60 minutes	14	24.6
> 60 minutes	6	10.5
Frequency Distribution of Sports Types		
Aerobic Activities	38	66.7
Anaerobic Activities	13	22.8
Others	6	10.5

Table 3 shows the 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. Of the 18 students who regularly exercise, 10 have a low IQ, 5 have a moderate IQ, and 3 have a good IQ. There are 39 students who do not exercise regularly: 31 have a low IQ, 7 have a

moderate IQ, and 1 has a good IQ. The results of the study indicate that students who regularly exercise tend to have better physical fitness indexes compared to students who do not exercise regularly. The majority of students who do not exercise regularly have a low IQ. The 18 students who exercise regularly consist of 10 students with a normal body fat percentage, four students with a fit body fat percentage, and four students with an obese body fat percentage. The number of students who do not exercise regularly is 39, consisting of 26 students with a normal body fat percentage, nine students with an obese body fat percentage, and four students with a fit body fat percentage (Table 3.8). Students who exercise regularly tend to have better body fat percentages because more of them fall into the standard and fit categories compared to students who do not exercise regularly. The majority of students who do not exercise regularly have a normal body fat percentage.

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

Cathegory	Physical Fitness Index				
	Not enough	Currently	Good	Total	P-Value
Relationship between Body Fat Percentage and Physical Fitness					
Fit	2	4	2	8	
Normal	27	7	2	36	0.015
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

Characteristics of Study Participants

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 IKJ, 12 (21.1%) had a moderate IKJ, and 4 (7%) had a good IKJ. 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.

The Relationship between Body Fat Percentage and Physical Fitness

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 et al. in 2020, 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 IKJ.

This is consistent with research conducted by Krisdianamurtirin et al. in 1993, 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).

Excessive increases in body fat percentage can have several impacts, including:

1. Physical workloads become heavier, which can reduce the ability to exercise.
2. Fat accumulation in the abdominal area can restrict waist movement, making activities such as bending forward difficult.
3. Fat accumulation in skeletal muscle can inhibit muscle contraction, negatively impacting performance in terms of endurance, flexibility, agility, speed, and other qualities.
4. Obese individuals generally have lower gas exchange and oxygen utilization rates and are susceptible to oxygen deprivation, resulting in decreased endurance exercise capacity (Li et al., 2022)

Research conducted by Effendy et al. in 2018 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 & Burtscher, 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 et al., 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.

Research Limitations

This study only examines the effect of physical fitness on body fat percentage in students from the Faculty of Medicine, Indonesian Christian University, Class of 2023. Another factor that could influence the study results is the respondents' low physical performance during data collection.

Conclusion

Based on the results of the physical fitness index, the distribution of the study sample involving 57 participants, namely students from the Faculty of Medicine, Universitas Kristen Indonesia (UKI) class of 2023, showed that the majority had a low Physical Fitness Index (PIJ). Furthermore, there was a significant relationship between body fat percentage and physical fitness, with a p-value of 0.015.

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Workflow **Publication**

Submission **Review** **Copyediting** **Production**

Round 1

Round 1 Status
Submission accepted.

Reviewer's Attachments

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3513 0. JANH. Peer Review Summary Report – 3 Reviewers.docx	August 9, 2025	

Revisions

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Review Discussions

Add discussion

Name	From	Last Reply	Replies	Closed
Revision	herusuwardianto 2025-08-10 11:52 AM	-	0	
Article Revision_Frisca	chome23 2025-08-10 04:17 PM	-	0	

REVIEW COMMENTS FOR MANUSCRIPT REVISION

This document contains the review results from three independent reviewers regarding your submitted manuscript to the Journal of Applied Nursing and Health (JANH). Each reviewer has provided constructive feedback and professional recommendations in accordance with the journal's academic standards.
You are required to revise your manuscript in accordance with the comments and suggestions provided by all three reviewers, including aspects of content, methodology, references, and language. Please submit the revised manuscript along with a response letter detailing the changes made in response to each comment.

Title:

The Relationship between Body Fat Percentage and Physical Fitness

Comments from Reviewer 1

A. Title

The title reflects the main variables but lacks specification of the study design and target population. The country name is not included, which is acceptable for generalization, but the academic audience would benefit from knowing the context.

Add "A Cross-Sectional Study among Medical Students in Indonesia" to clarify the design and population.

B. Abstract

The background introduces the topic but does not explicitly state the research gap (e.g., "However, few studies…"). The methods mention the design, sample size, and instruments but omit inclusion/exclusion criteria, sampling method, and statistical tests in detail. The p-value is given as 0.015 (correct), but the text still uses <0.0001 in methods without consistency. No mention of reporting guidelines (STROBE) is made. Keywords are only three and not formatted per MeSH.

Add one sentence in the background stating the research gap; include sampling technique, inclusion/exclusion criteria, statistical test used, and ethical approval; specify STROBE adherence; expand keywords to 3–6 MeSH terms separated by semicolons.

C. Introduction

Contains global and national prevalence but lacks explicit data progression (global → national → local). No clear gap is highlighted, and

no conceptual framework is explained linking body fat % and physical fitness.

Include explicit gap statement; add a conceptual/theoretical framework; link prior studies to study variables; provide local prevalence data.

D. Method
Study Design: Mentioned as observational cross-sectional, but should be in a subheading.

Participants: Sampling method mentioned (random sampling, Slovin formula) but lacks sample size calculation detail and justification; missing country name in location description; inclusion/exclusion criteria not explicitly listed.

Instruments: Name and type of instruments given, but no details on validity/reliability; no reference for skinfold caliper measurement; no instrument appendix.

Intervention: Not applicable — state clearly that there was no intervention.

Data Collection: Timeline given but lacks who collected data; no training procedure for data collectors mentioned.

Data Analysis: States software? (No — missing). Should specify SPSS version and why Chi-square was chosen. P-value thresholds inconsistent.

Ethical Approval: No ethics committee name or approval number given.

E. Results
Tables not labeled per journal style (titles inconsistent, “Cathegory” misspelled). Data descriptions repeat table content. No confidence intervals or effect sizes reported.

Combine demographic variables in one table; report CIs; reference tables in narrative correctly.

F. Discussion

Good comparison with previous studies, but some claims are overextended without data support. Limitations section exists but is minimal. No explicit link to the conceptual framework.

Expand limitations, connect findings to theory, avoid overgeneralization.

G. Relevance to Clinical Practice
Missing as a standalone section.

Add one paragraph summarizing how findings can guide interventions in medical student populations.

H. Conclusion
Summarizes results but lacks practical recommendations.

Include implications for health promotion programs and policy.

I. References
Mixed APA formatting; some older than 10 years; some URLs incomplete; not all in-text citations are present in the reference list (e.g., "5" in obesity section).

Ensure ≥80% from last 10 years, consistent APA 7 style, manage with Mendeley, and cross-check for missing/inconsistent citations.

Comments from Reviewer 2

Evaluation: Uses US spelling inconsistently ("behaviour" vs "behavior" not checked, but minor). Sentence structure occasionally awkward ("...resulting in the data used in this study"). Overuse of passive voice in methods.

Abstract results match main results, but methods in abstract omit details found in full text. Discussion aligns with results, but abstract conclusion is too general.

Ensure abstract mirrors methods and key findings; keep terminology consistent ("Physical Fitness Index" vs "PFI" vs "IKJ" should be unified).

No explicit conceptual model guiding variable selection.

Add a short conceptual rationale in introduction.

“Cathegory” → “Category” (Table headings).

Replace inconsistent p-value thresholds (use <0.001 instead of <0.0001).

Change “...did not fall under the study's exclusion criteria” → “…met all inclusion criteria and no exclusion criteria applied.”

Suggested workflow for data collection:

- Recruitment of eligible participants (random sampling via Slovin).
- Screening for inclusion/exclusion criteria.
- Measurement of body fat % (skinfold caliper).
- Harvard Step Test for physical fitness.
- Data entry into spreadsheet.
- Statistical analysis (Chi-square).

Inconsistent use — PFI, PIJ, IKJ used interchangeably.

Introduce abbreviation once (e.g., Physical Fitness Index [PFI]) and use consistently throughout.

Addresses an under-researched link in Indonesian medical students, but similar studies exist internationally. Novelty is moderate due to local population focus.

Emphasize cultural or educational setting differences in introduction to strengthen novelty claim.

Comments from Reviewer 3

Your manuscript requires revisions to align with the journal's writing and formatting standards. We kindly request that you:

1. **Revise the manuscript** according to the **Author Guidelines**, which can be

accessed at the following link:
https://janh.candle.or.id/index.php/janh/authorguidelines

2. **Download and format your manuscript** using the official journal **template**, available here: https://drive.google.com/drive/folders/1-z2gS28ox2kX29QxNqzZ0Mfcp9kt0Xxk

3. **Outline manuscript**

A. Title
B. Abstract
C. **Relevance to Clinical Practice**→ Content is missing and should be added
D. Introduction
E. Method
1. **Study Design**
2. **Participants**
- Location (Country)
- Inclusion Criteria
- Exclusion Criteria
- Sample Size and Justification
- Sampling Method
3. **Instruments**
- Development/Adaptation
- Validity and Reliability
- Scoring and Categories
4. **Intervention**
- SOP Description of the Intervention
- Duration and Frequency
- Implementer/Facilitator
5. **Data Collection**
- Time and Place
- Data Collection Process
- Enumerators/Assistants (if any)
6. **Data Analysis**
- Software Used
- Statistical Tests and Rationale
- p-value, Confidence Interval (CI), and Effect Size
7. **Ethical Approval**
- Name of Approving Institution
- Ethical Approval Number
- Informed Consent Process
F. Result
G. Discussion
H. **Relevance to Clinical Practice** → Content is missing and should be

added

I. **Conclusion**
J. **Reference**

4. Discussion: No numerical or quantitative values.
5. Conclusion: Present the conclusion and recommendations, not a repetition of the results.

6. **In Result: Prepare clear and well-structured tables for demographic characteristics and study variables.**

- The demographic data table is presented in a single table with frequencies and percentages (n, %).
- The research variable data and statistical test results are presented in a single table with frequencies and percentages (n, %) along with the corresponding statistical analysis.

Example tables:

Table 1. Demographic Characteristics of Respondents

Characteristic	Category	n (%)
Gender	Male	xx (xx.x)
	Female	xx (xx.x)
Age (years)	18–25	xx (xx.x)
	26–35	xx (xx.x)
	36–45	xx (xx.x)
	46–55	xx (xx.x)
	>55	xx (xx.x)
Educational Level	Primary school	xx (xx.x)
	Junior high school	xx (xx.x)
	Senior high school	xx (xx.x)
	Diploma	xx (xx.x)
	Bachelor's degree	xx (xx.x)
	Master's/Doctoral degree	xx (xx.x)
Marital Status	Single	xx (xx.x)
	Married	xx (xx.x)
	Widowed/Divorced	xx (xx.x)
Occupation	Unemployed	xx (xx.x)
	Housewife	xx (xx.x)
	Government/private	xx (xx.x)

	employee	
	Entrepreneur	xx (xx.x)
	Others	xx (xx.x)
Total		N (100)

Table 2. Knowledge, Attitude, and Behavior of Participants (n (%), Mean ± SD) and Statistical Tests

Variable (format)	Category / Cut-off	n (%) or Mean ± SD	Statistic (test)	p-value
Knowledge (categorical)	Good	xx (xx.x)	Chi-square/Fisher exact	p = 0.xxx
	Poor	xx (xx.x)		
Knowledge (continuous)	Score (0–100)	xx.x ± x.x	t-test / Mann–Whitney U / ANOVA / Kruskal–Wallis	p = 0.xxx
Attitude (categorical)	Positive	xx (xx.x)	Chi-square/Fisher exact	p = 0.xxx
	Negative	xx (xx.x)		
Attitude (continuous)	Score (0–100)	xx.x ± x.x	t-test / Mann–Whitney U / ANOVA / Kruskal–Wallis	p = 0.xxx
Behavior (categorical)	Good/Appropriate	xx (xx.x)	Chi-square/Fisher exact	p = 0.xxx
	Poor/Inappropriate	xx (xx.x)		
Behavior (continuous)	Score (0–100)	xx.x ± x.x	t-test / Mann–Whitney U / ANOVA / Kruskal–Wallis	p = 0.xxx

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 an individual's capacity to perform tasks efficiently, both in leisure time and in daily life. Physical fitness is considered good if daily physical activities can be performed routinely and without excessive fatigue, which, as a consequence, reduces the risk of developing chronic diseases early. However, limited studies have specifically examined the relationship between body fat percentage and physical fitness among medical students in Indonesia, creating a research gap. Objective: This study aims to analyze the relationship between body fat percentage and physical fitness in students of the Faculty of Medicine, Indonesian Christian University, intake of 2023. 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, while exclusion criteria included 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 results 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.

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 et al., 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 & 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 & Selenica, 2022). Body composition is a component of fitness that is related to health (Kathleen Mahan & 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 et al., 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 & 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 et al., 2023; Prabowo et al., 2021).

One way to assess a person's fitness level is to use a fitness test called the Harvard Step Test (HST) (Shoebuddin & 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 et al., 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 x test duration in seconds) / (5.5 x number of heart rate recovery times) (Zakiuddin et al., 2016).

This study is grounded in the health-related fitness model, which posits that body composition, including body fat percentage, directly affects cardiovascular endurance and overall physical performance. Excess body fat impairs oxygen utilization and muscle efficiency, which in turn lowers measured fitness scores. In this model, body fat percentage is the independent variable, and physical fitness level is the dependent variable, with lifestyle and activity level as potential confounding factors.

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.

Research Location and Timeline

The research was conducted at the Faculty of Medicine, Christian University of Indonesia. Data collection, processing, and implementation were conducted from September 2024 to February 2025.

Participants

The research was conducted at the Faculty of Medicine, Christian University of Indonesia, Jakarta, Indonesia. Data collection, processing, and implementation were carried out from September 2024 to February 2025. The minimum required sample size was calculated using the correlation study sample size formula, a sample of 57 participants met the inclusion (Active medical students of the Faculty of Medicine, Universitas Kristen Indonesia, Class of 2023; Aged 17–25 years and Willing to participate and signed informed consent), and exclusion criteria (Students with known musculoskeletal disorders, cardiovascular diseases, or chronic illnesses affecting physical performance; Students currently under medication that influences cardiovascular or

metabolic function and Students unable to complete the Harvard Step Test due to injury or illness during data collection).

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Data Collection & Data Analysis

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.

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.

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

Characteristic	Frequency	Percentage
Age		
18 years	4	7
19 years	36	63.2
20 years	16	28.1
21 years	1	1.8
Gender		
Male	22	38.6
Female	35	61.4

Table 2 presents data on the frequency of exercise activities undertaken by respondents. The data shows that 39 students (68.4%) did not exercise regularly, while 18 students (31.6%) exercised regularly. Thirteen students (22.8%) never exercised per week, 36 students (63.2%) exercised once or twice a week, five students (8.8%) exercised three to four times a week, and three students (5.3%) exercised five or more times a week. Thirteen students (22.8%) exercised for less than 15 minutes, 24 students (42.1%) exercised for 15-30 minutes, 14 students (24.6%) exercised for 30-60 minutes, and six students (10.5%) exercised for more than 60 minutes. Aerobic exercise was the most common type of exercise among students, with 38 students (66.7%) participating. Meanwhile, 13 students (22.8%) participated in non-aerobic exercise, and 6 students (10.5%) participated in other types of exercise.

Table 2. Knowledge, Attitude, and Behavior of Participants

Category	Frequency	Percentage
Physical Fitness Index		
Poor	41	71.9
Moderate	12	21.1
Good	4	7
Body Fat Percentage		
Essential Fats	0	0
Athletes	0	0
Fit	8	14
Normal	36	63.2
Obesity	13	22.8
Frequency Distribution of Exercise Habits		
Routine	18	31.6
Not Routine	39	68.4
Distribution of Exercise Frequency in a Week		
Never	13	22.8
1-2 times	36	63.2
3-4 times	5	8.8
5 times or more	3	5.3
Frequency Distribution of Exercise Duration		
< 15 minutes	13	22.8
15 – 30 minutes	24	42.1
30 – 60 minutes	14	24.6
> 60 minutes	6	10.5
Frequency Distribution of Sports Types		
Aerobic Activities	38	66.7
Anaerobic Activities	13	22.8
Others	6	10.5

Table 3 below presents the results of a bivariate analysis examining the relationship between body fat percentage and physical fitness, as well as the distribution of physical fitness index and body fat percentage based on exercise habits. Of the 18 students who regularly exercise, 39 do not exercise regularly. The results of the study indicate that students who regularly exercise tend to have better physical fitness indexes compared to students who do not exercise regularly.

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				
	Not enough	Currently	Good	Total	P-Value

Relationship between Body Fat Percentage and Physical Fitness					
Fit	2	4	2	8	
Normal	27	7	2	36	0.015
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

Characteristics of Study Participants

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.

The Relationship between Body Fat Percentage and Physical Fitness

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 Krisdianamurtirin, 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).

Excessive increases in body fat percentage can have several impacts, including:

1. Physical workloads become heavier, which can reduce the ability to exercise.
2. Fat accumulation in the abdominal area can restrict waist movement, making activities such as bending forward difficult.
3. Fat accumulation in skeletal muscle can inhibit muscle contraction, negatively impacting performance in terms of endurance, flexibility, agility, speed, and other qualities.
4. Obese individuals generally have lower gas exchange and oxygen utilization rates and are susceptible to oxygen deprivation, resulting in decreased endurance exercise capacity (Li et al., 2022)

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 & Burtscher, 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 et al., 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.

Research Limitations

This study only examines the effect of physical fitness on body fat percentage in students from the Faculty of Medicine, Indonesian Christian University, Class of 2023. Another factor that could influence the study results is the respondents' low physical performance during data collection.

RELEVANCE TO CLINICAL PRACTICE

The findings of this study can serve as a basis for designing interventions tailored to the unique lifestyle and workload of medical students. Given the significant relationship between higher body fat percentage and lower physical fitness, interventions should

focus on integrating feasible and enjoyable physical activity options within the demanding academic schedules of medical students. Strategies may include incorporating short, high-intensity exercise sessions between classes, providing access to on-campus fitness facilities, offering time management workshops to balance study and exercise, and organizing peer-led sports or wellness clubs. Additionally, periodic body composition and fitness screenings can be implemented to monitor progress and motivate students to maintain a healthy lifestyle. By addressing both physical activity and nutrition, such interventions can help prevent early onset of obesity-related conditions and improve overall well-being in this population.

Conclusion

Based on the results of the physical fitness index, the distribution of the study sample involving 57 participants, namely students from the Faculty of Medicine, Universitas Kristen Indonesia (UKI) Class of 2023, showed that the majority had a low Physical Fitness Index (PFI). Furthermore, there was a significant relationship between body fat percentage and physical fitness, with a p-value of 0.015. These findings highlight the need for targeted health promotion programs within medical schools, such as structured physical activity initiatives, nutritional counseling, and awareness campaigns to maintain optimal body composition. From a policy perspective, universities could integrate regular fitness assessments and wellness activities into the academic calendar, ensuring that student health is prioritized alongside academic performance, ultimately supporting long-term prevention of lifestyle-related chronic diseases.

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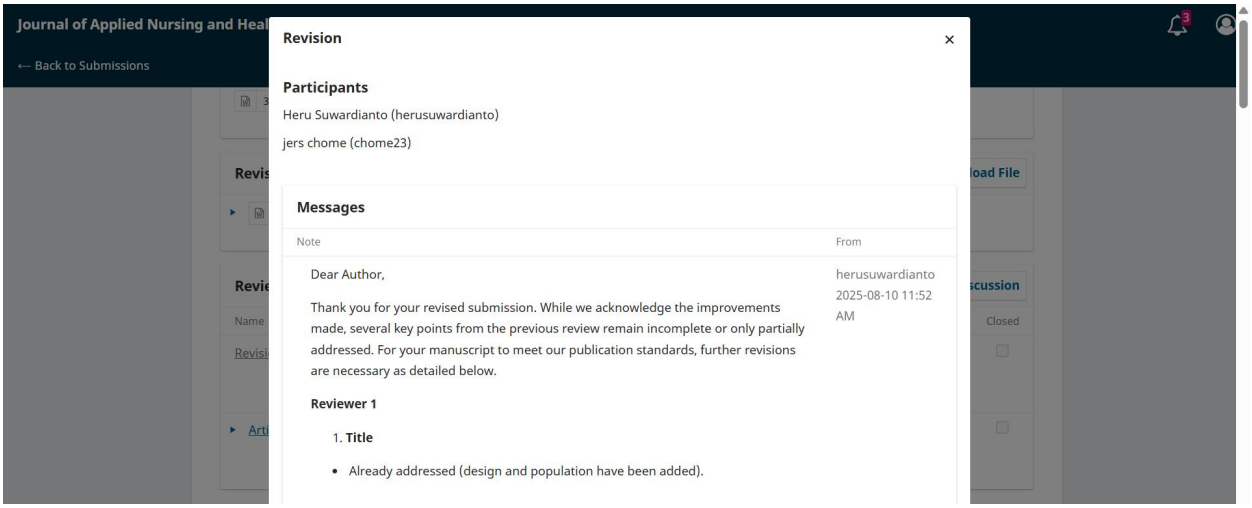
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Revision
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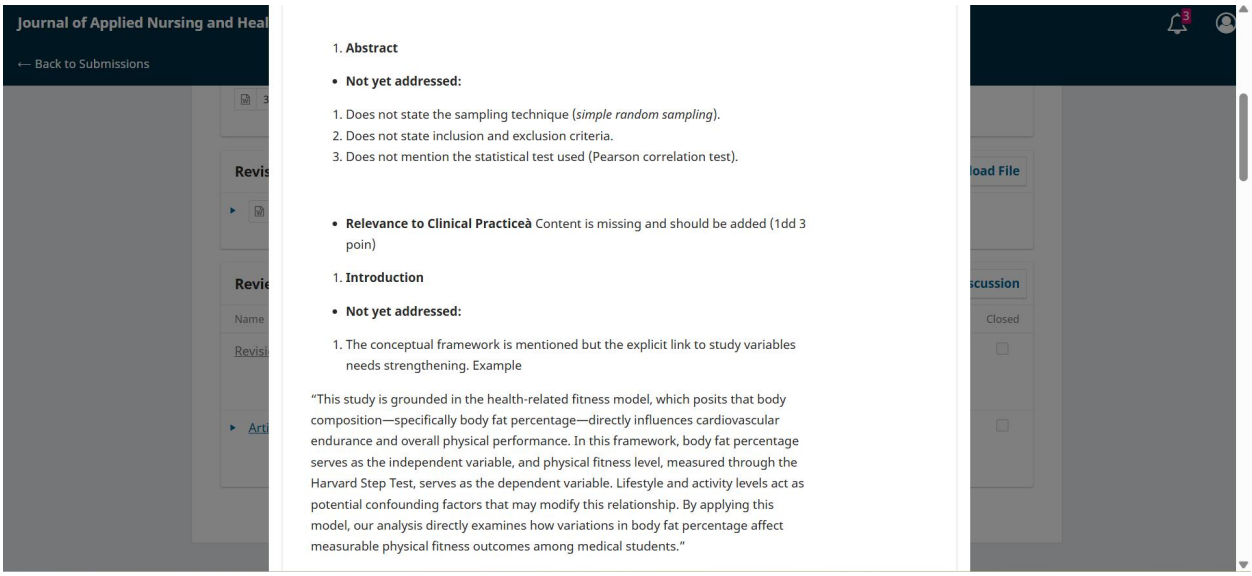
Messages
Note
From
Dear Author,
herusuwardianto
2025-08-10 11:52 AM
Thank you for your revised submission. While we acknowledge the improvements made, several key points from the previous review remain incomplete or only partially addressed. For your manuscript to meet our publication standards, further revisions are necessary as detailed below.
Reviewer 1
1. Title
• Already addressed (design and population have been added).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1. Abstract
• Not yet addressed:
1. Does not state the sampling technique (simple random sampling).
2. Does not state inclusion and exclusion criteria.
3. Does not mention the statistical test used (Pearson correlation test).
• Relevance to Clinical Practiceà Content is missing and should be added (1dd 3 poin)
1. Introduction
• Not yet addressed:
1. The conceptual framework is mentioned but the explicit link to study variables needs strengthening. Example
"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."


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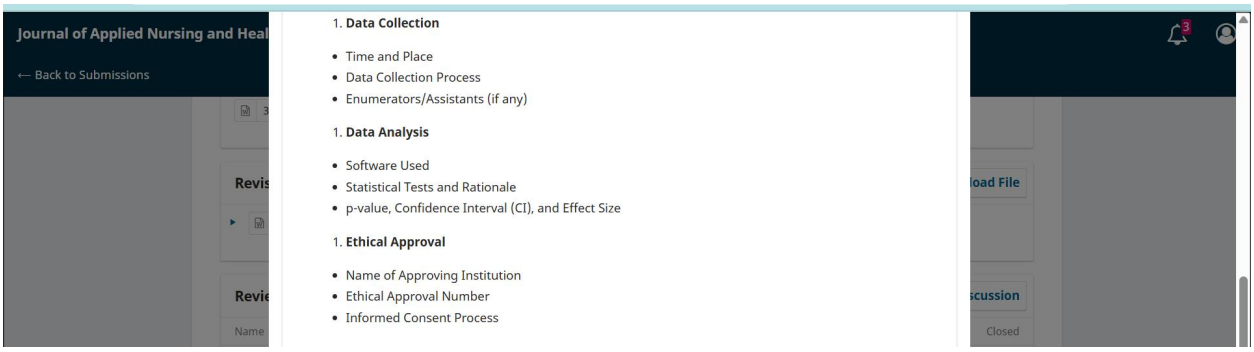
1. Method
Use tamplate:
1. Method
2. Study Design
3. Participants
• Location (Country)
• Inclusion Criteria
• Exclusion Criteria
• Sample Size and Justification
• Sampling Method
1. Instruments
• Development/Adaptation
• Validity and Reliability
• Scoring and Categories
1. Intervention (optional)
• SOP Description of the Intervention
• Duration and Frequency
• Implementer/Facilitator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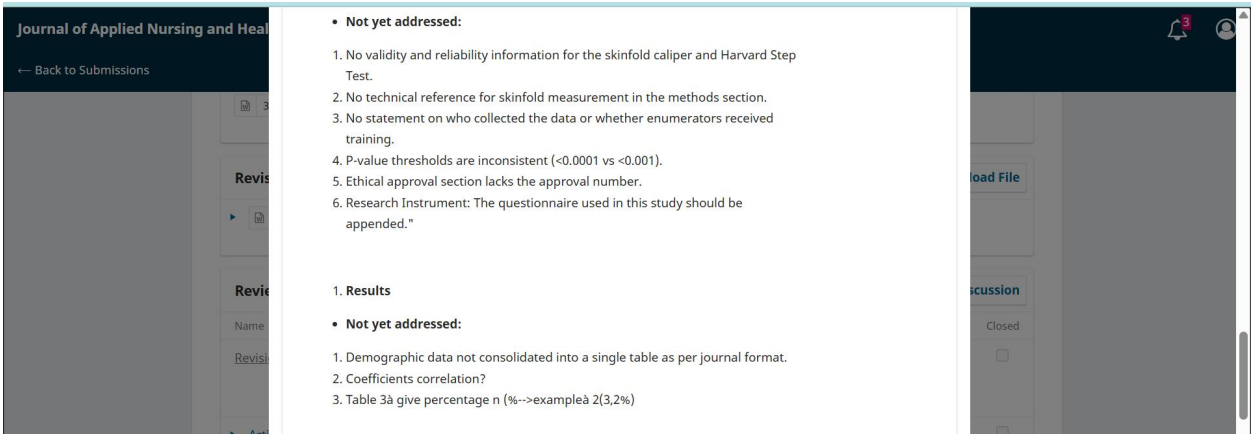
1. Data Collection
• Time and Place
• Data Collection Process
• Enumerators/Assistants (if any)
1. Data Analysis
• Software Used
• Statistical Tests and Rationale
• p-value, Confidence Interval (CI), and Effect Size
1. Ethical Approval
• Name of Approving Institution
• Ethical Approval Number
• Informed Consent Process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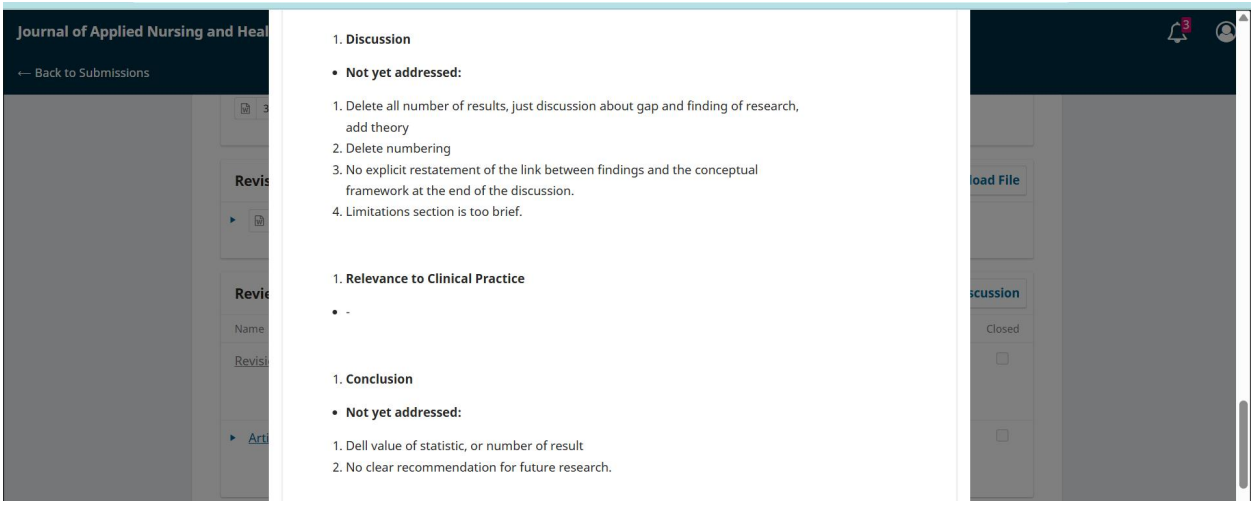
• Not yet addressed:
1. No validity and reliability information for the skinfold caliper and Harvard Step Test.
2. No technical reference for skinfold measurement in the methods section.
3. No statement on who collected the data or whether enumerators received training.
4. P-value thresholds are inconsistent (<0.0001 vs <0.001).
5. Ethical approval section lacks the approval number.
6. Research Instrument: The questionnaire used in this study should be appended."
1. Results
• Not yet addressed:
1. Demographic data not consolidated into a single table as per journal format.
2. Coefficients correlation?
3. Table 3à give percentage n (%-->exampleà 2(3,2%)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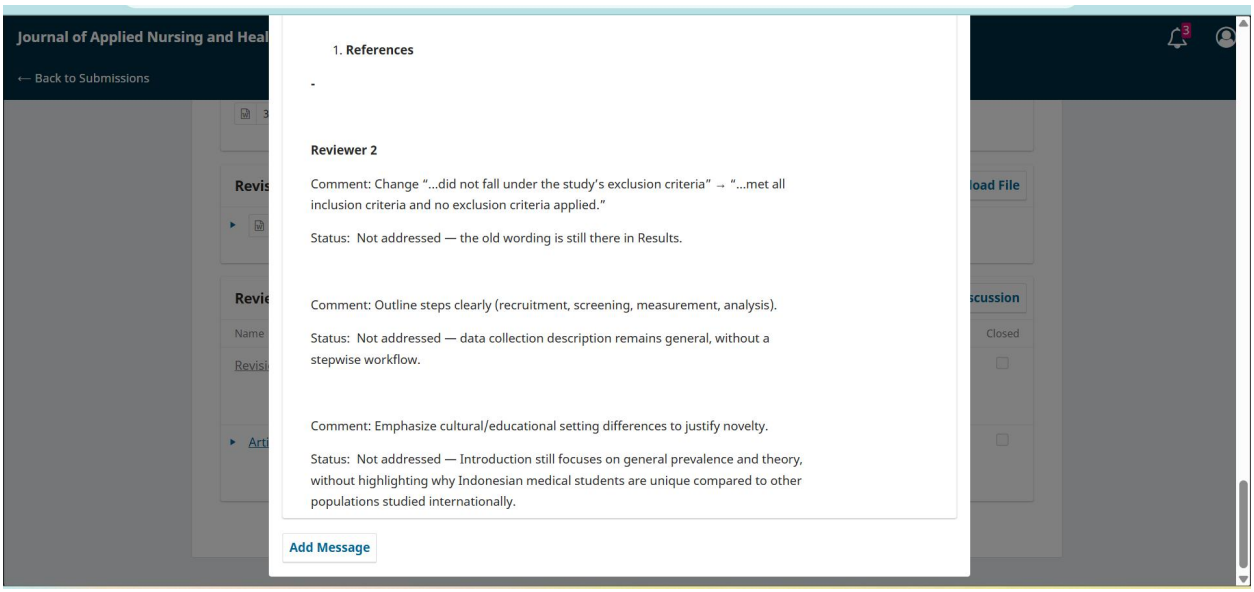
1. Discussion
• Not yet addressed:
1. Delete all number of results, just discussion about gap and finding of research, add theory
2. Delete numbering
3. No explicit restatement of the link between findings and the conceptual framework at the end of the discussion.
4. Limitations section is too brief.
1. Relevance to Clinical Practice
• -
1. Conclusion
• Not yet addressed:
1. Dell value of statistic, or number of result
2. No clear recommendation for future research.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1. References
-
Reviewer 2
Comment: Change "...did not fall under the study's exclusion criteria" → "...met all inclusion criteria and no exclusion criteria applied."
Status: Not addressed — the old wording is still there in Results.
Comment: Outline steps clearly (recruitment, screening, measurement, analysis).
Status: Not addressed — data collection description remains general, without a stepwise workflow.
Comment: Emphasize cultural/educational setting differences to justify novelty.
Status: Not addressed — Introduction still focuses on general prevalence and theory, without highlighting why Indonesian medical students are unique compared to other populations studied internationally.
Add Message

Title

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

Abstract

Background: Physical fitness is an individual's capacity to perform tasks efficiently, both in leisure time and in daily life. Physical fitness is considered good if daily physical activities can be performed routinely and without excessive fatigue, which, as a consequence, reduces the risk of developing chronic diseases early. However, limited studies have specifically examined the relationship between body fat percentage and physical fitness among medical students in Indonesia, creating a research gap.
Objective: This study aims to analyze the relationship between body fat percentage and physical fitness in students of the Faculty of Medicine, Indonesian Christian University, intake of 2023.
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: These findings highlight the need for regular physical activity programs and lifestyle interventions targeting body fat reduction among medical students. Universities should incorporate structured fitness assessments, health education, and physical activity promotion into their student wellness programs to improve physical performance and long-term health outcomes.

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 x test duration in seconds) / (5.5 x 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
- 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
- The sample size (57 respondents) was determined based on the minimum requirement for correlation analysis with an expected medium effect size, 80% statistical power, and 5% significance level. Participants were selected using simple random sampling.

Instrument

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 Consideration

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				
	Not enough	Currently	Good	Total	P-Value
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

Characteristics of Study Participants

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.

The Relationship between Body Fat Percentage and Physical Fitness

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 Krisdianamurtirin, 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 Burtscher 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.

Research Limitations

This study only examines the effect of physical fitness on body fat percentage in students from the Faculty of Medicine, Indonesian Christian University, Class of 2023. Another factor that could influence the study results is the respondents' low physical performance during data collection.

Relevance to Clinical Practice

The findings of this study can serve as a basis for designing interventions tailored to the unique lifestyle and workload of medical students. Given the significant relationship between higher body fat percentage and lower physical fitness, interventions should focus on integrating feasible and enjoyable physical activity options within the demanding academic schedules of medical students. Strategies may include incorporating short, high-intensity exercise sessions between classes, providing access to on-campus fitness facilities, offering time management workshops to balance study and exercise, and organizing peer-led sports or wellness clubs. Additionally, periodic body composition and fitness screenings can be implemented to monitor progress and motivate students to maintain a healthy lifestyle. By addressing both physical activity and nutrition, such interventions can help prevent early onset of obesity-related conditions and improve overall well-being in this population.

Conclusion

Based on the results of the physical fitness index, the distribution of the study sample involving 57 participants, namely students from the Faculty of Medicine, Universitas Kristen Indonesia (UKI) Class of 2023, showed that the majority had a low Physical

Fitness Index (PFI). Furthermore, there was a significant relationship between body fat percentage and physical fitness, with a p-value of 0.015. These findings highlight the need for targeted health promotion programs within medical schools, such as structured physical activity initiatives, nutritional counseling, and awareness campaigns to maintain optimal body composition. From a policy perspective, universities could integrate regular fitness assessments and wellness activities into the academic calendar, ensuring that student health is prioritized alongside academic performance, ultimately supporting long-term prevention of lifestyle-related chronic diseases.

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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 x test duration in seconds) / (5.5 x 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				
	Not enough	Currently	Good	Total	P-Value
Relationship between Body Fat Percentage and Physical Fitness					
Fit	2	4	2	8	
Normal	27	7	2	36	0.015
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.

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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 Krisdianamurtirin, 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 Burtscher 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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