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Body mass index (BMI) and cardiovascular endurance among medical students

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Abstract

Background: A person's general well-being is greatly influenced by their cardiovascular health and the main indicator for assessing cardiovascular disease risk is Body Mass Index (BMI). Understanding the relationship between BMI and cardiovascular endurance is becoming increasingly important as obesity and overweight become health problems worldwide, especially among young people.

Purpose: To explore the relationship between BMI and cardiovascular endurance among college students.

Method: Observational analytical research with a cross-sectional design and involving a purposively selected sample of 60 respondents. This study was conducted at the Physiology Laboratory of the Faculty of Medicine, Dentistry, and Public Health, Universitas Prima Indonesia in March 2024. The BMI variable was calculated based on respondents' height and weight data, while cardiovascular endurance was evaluated using the Harvard step test. Data were analyzed using the univariate and bivariate Spearman's rho correlation test.

Results: Shows a very weak relationship between gender variables and cardiovascular endurance (correlation coefficient 0.149 and significance value $0.255 > 0.05$). Likewise, the age variable obtained a correlation coefficient of 0.073 with a significance value of $0.581 > 0.05$, and the BMI variable with a correlation coefficient of -0.220 and a significance value of $0.091 > 0.05$.

Conclusion: BMI, gender, and age did not significantly affect cardiovascular fitness among college students. On the other hand, factors beyond BMI, such as physical activity, play a more important role in determining cardiovascular health, so a holistic approach is needed to improve cardiovascular fitness.

Suggestion: Students should do regular physical exercise and maintain normal body weight to maintain cardiovascular endurance in achieving physical fitness. Increase cardiovascular endurance, either through consuming healthy and balanced foods or doing regular physical activities such as morning walks, cycling, or heart fitness training. In addition, further researchers can conduct further research on other factors that affect cardiovascular endurance such as fatigue factors and sleep quality.

Keywords: Body Mass Index (BMI); Cardiovascular Endurance; Medical Students.

INTRODUCTION

The maintenance of cardiovascular health is crucial for the overall welfare of persons. The body mass index (BMI) is a widely used metric for assessing an individual's general health, particularly in regard to coronary disease susceptibility (Elagizi, Kachur, Carbone, Lavie, & Blair, 2020; Golubnitschaja, Liskova, Koklesova, Samec, Biringer, Büsselberg, & Kubatka, 2021; Piqueras, Ballester, Durá-Gil, Martínez-Hervas, Redón, & Real, 2021). As

societies adopt a more contemporary way of living, the occurrence of obesity and overweight has steadily increased in many nations, including Indonesia. World Health Organisation (WHO) reports that almost 39% of people globally are overweight, with 13% of them categorised as obese (World Health Organization, 2024). These chronic diseases, including coronary heart disease, type 2 diabetes, and hypertension, are exacerbated by obesity, which not only impacts

physical appearance but also raises the risk of other chronic illnesses (Elagizi et al., 2020; La Sala & Pontiroli, 2020). Therefore, it is crucial to investigate the correlation between BMI and cardiovascular health in order to discover efficient methods to lower the risk of these illnesses via weight management.

Extensive research has shown that obesity significantly increases the likelihood of developing cardiovascular disease, especially in teenagers and young adults. Previous studies have shown that women have a greater incidence of obesity than males, and this prevalence particularly rises with maturity (Chen, Peng, Yang, Zheng, Wang, & Lu, 2019; Ma, Xi, Yang, Sun, Zhao, & Bovet, 2021; Wang, Beydoun, Min, Xue, Kaminsky, & Cheskin, 2020). This phenomena extends beyond industrialized nations and is also starting to impact developing countries such as Indonesia, where shifts in food habits and reduced physical activity are the primary influences behind the increase in obesity rates (Hanifah, Nasrulloh, & Sufyan, 2023; Lisetyaningrum, Pujasari, & Kuntarti, 2021). Insufficient knowledge of the benefits of preserving health via a well-balanced diet and consistent physical exercise worsens the problem. Among teenagers and young people in Indonesia, the incidence of obesity is steadily increasing, which poses a greater risk of cardiovascular illness in the future (Murni, Sulistyoningrum, Susilowati, Julia, & Dickinson, 2022; Oddo, Maehara, & Rah, 2019).

To effectively address this issue, it is necessary to develop comprehensive solutions that can be widely adopted, especially among high-risk populations such as medical students. Medical students, who are provided with more health information, should serve as role models in adopting a healthy lifestyle. However, it is true that individuals are still vulnerable to engaging in unhealthy behaviors (Von Ah, Ebert, Ngamvitroj, Park, & Kang, 2004; Cena, Porri, De Giuseppe, Kalmpourtzidou, Salvatore, El Ghoch, & Kolčić, 2021; Dragun, Veček, Marendić, Pribisalić, Đivić, Cena, & Kolčić, 2020). Therefore, it is imperative to promote a healthy lifestyle and provide comprehensive health education to medical students. Regular physical exercise and proper calorie management play an important role in preventing and reducing obesity, as well as improving cardiovascular fitness and muscular endurance (Franklin, Eijsvogels, Pandey, Quindry, & Toth, 2022).

To understand the relationship between BMI and cardiovascular health, it is essential to consider energy balance (Bo, Fadda, Fedele, Pellegrini, Ghigo, & Pellegrini, 2020; Ludwig, Apovian, Aronne, Astrup, Cantley, Ebbeling, & Friedman, 2022). To maintain a healthy body weight, it is essential to balance energy intake and expenditure (Jehan, Zizi, Pandi-Perumal, McFarlane, Jean-Louis, & Myers, 2020). Uneven energy distribution due to excessive calorie consumption or inadequate physical exercise can lead to increased BMI and obesity. Furthermore, physical fitness places significant emphasis on the need for cardiovascular endurance to maintain heart and blood vessel health (Franklin et al., 2022; Moreira, Wohlwend, & Wisløff, 2020). Previous studies have shown that individuals with high body mass index (BMI) often have an undesirable lipid profile, characterized by elevated levels of low-density lipoprotein (LDL) cholesterol and triglycerides. These lipids have been shown to be important risk factors for coronary heart disease (Shabana, Shahid, & Sarwar, 2020; Tajik, Voutilainen, Kauhanen, Mazidi, Lip, Tuomainen, & Isanejad, 2022). Therefore, actively managing BMI through improving cardiovascular fitness is an important preventive measure.

This study attempts to fill the gap in the current literature by exploring the relationship between BMI and cardiovascular fitness in medical students. Although many studies have investigated body parameters associated with cardiovascular risk, this study stands out for its focus on the Indonesian medical student population, which is not comprehensive. Previous studies examining cardiovascular disease risk factors among Indian medical students provide relevant insights, albeit in a different context (Mukhopadhyay, Mukherjee, Khanra, Samanta, Karak, & Guha, 2021). Additionally, studies examining the relationship between cardiovascular fitness and obesity in different populations have also shown relevance, albeit in different regions (Deusdará, de Moura Souza, & Szklo, 2022; Haapala, Lee, & Laukkanen, 2020).

RESEARCH METHOD

Analytical observational study with cross-sectional design to determine the relationship between body mass index and cardiovascular endurance in college students. This study was conducted at the Physiology Laboratory of the Faculty of Medicine, Dentistry, and

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Public Health, Universitas Prima Indonesia in March 2024. Sampling was carried out using a non-probability sampling purposive sampling approach from the available population, the sample size was calculated using the Slovin formula and 60 respondents were obtained.

The sample inclusion criteria were students who were willing to participate, had no history of heart disease, and were sixth semester students, while the exclusion criteria were students who were not used to exercising, had a history of heart disease, and were not sixth semester students. The independent variable examined in this study was body mass index (BMI), while the dependent variable was cardiovascular endurance.

BMI is obtained from the results of body weight and height measurements (scales and microtoise staturmeter) which are categorized into 5, namely underweight if BMI <18.5 kg/m², normal if 18.5-22.9

kg/m², overweight if 23.0-24.9 kg/m², obesity I if 25.0-29.9 kg/m², and obesity II if ≥ 30.0 kg/m². Cardiovascular endurance is assessed using the Harvard step test with a metronome beat, then categorized into 5, namely excellent if the index is ≤ 90 , good if the index is 80-89, average if the index is 65-79, low average if the index is 55-64, and poor if ≥ 54 .

Data analysis using univariate and bivariate analysis approaches using IBM SPSS 26. Bivariate analysis through the use of the Kolmogorov-Smirnov technique, normality tests are carried out to ensure whether the data is normally distributed. If the data distribution is not normal, the Spearman Rho correlation test will be used. This research has obtained ethical permission from the Health Research Ethics Committee of Universitas Prima Indonesia with letter number: 095/KEPK/UNPRI/11/2024.

RESEARCH RESULTS

Table 1. Distribution of Respondents Characteristics (N=60)

Variables	Results
Age (Mean\pmSD)(Range)(Years)	(21.4 \pm 1.2)(19-24)
Age (n/%)	
19	3/5.0
20	6/10.0
21	27/45.0
22	10/16.7
23	11/18.3
24	3/5.0
Gender (n/%)	
Male	49/81.7
Female	11/18.3
BMI (Mean\pmSD)(Range)(kg/m²)	(21.4 \pm 1.2)(16-38)
BMI (n/%)	
Underweight	3/5.0
Normal	28/46.7
Overweight	9/15.0
Obesity I	8/13.3
Obesity II	12/20.0
Cardiovascular Endurance (n/%)	(63 \pm 9.013)(47-86)
Good	2/3.0
Average	21/35.0
Low Average	26/43.7
Poor	11/18.3

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Table 1 shows the average age of respondents is 21.4 years with a standard deviation of 1.2 in the age range of 19-24 years. The majority are male, which is 49 respondents (81.7%) and have a normal body mass index category of 28 respondents (46.7%) with an average of 21.4 kg/m² and a standard deviation of 1.2 in the age range of 16-38 kg/m². In addition, the majority of respondents have low average cardiovascular endurance, which is 26 respondents (43.7%).

Table 2. Spearman Rho Test for the Relationship between Two Variables

Variables	Cardiovascular Endurance	
	Establishing Correlation Coefficient	Significance (2-tailed)
Gender	0.149	0.255
Age	0.073	0.581
BMI	-0.220	0.091

Table 2 shows a very weak relationship (correlation coefficient 0.149 and significance value 0.255 > 0.05) between the gender variable and cardiovascular endurance. For the age variable, a correlation coefficient of 0.073 and a significance value of 0.581 > 0.05 was obtained. This indicates that there is no statistically significant relationship between age and cardiovascular endurance. In addition, a very weak and negative relationship was obtained between BMI and cardiovascular endurance with a correlation coefficient of -0.220 and a significance value of 0.091 > 0.05. This indicates that there is no statistically significant relationship between the two variables.

DISCUSSION

Based on the frequency distribution analysis, of the 60 respondents, the majority were male, namely 49 respondents (81.7%), while the rest were female, namely 11 respondents (18.3%). The age range of the respondents was mostly 21 years, with the number of respondents being 27 (45.0%). The results of the Body Mass Index (BMI) analysis showed that most respondents had a BMI in the normal category of 28 (46.7%). In terms of cardiovascular endurance, the results of the study showed that most respondents had low average cardiovascular endurance, namely 26 respondents (43.3%). The results of this study are in accordance with several previous studies that found a strong negative correlation between BMI and cardiopulmonary endurance in students, an increase in BMI tends to be followed by a decrease in VO₂Max values (Damayanti & Adriani, 2021; Khairani, Adriani, & Amani, 2021; Shiba & Shiba, 2020). This is in accordance with the results of this study, with the majority of respondents with poor cardiovascular

endurance also being in the overweight to obese category.

In contrast to previous studies showing that BMI affects cardiovascular fitness, individuals with higher BMI tend to have decreased physiological heart function, which in turn affects cardiovascular endurance (Powell-Wiley, Poirier, Burke, Després, Gordon-Larsen, & Lavie, 2021). However, these results also suggest that, although most respondents had normal BMI, they still had poor cardiovascular endurance. In addition to BMI, other factors, such as physical activity level, may be important in determining cardiovascular fitness. Other studies support the findings of this study, stating that in addition to BMI, other variables such as type of exercise and duration of exercise also significantly affect cardiovascular endurance (Kurniawan, Rahadianti, Ruqayyah, & Priono, 2024). This suggests that to improve cardiovascular endurance, it is important to focus on BMI and consider overall physical activity levels.

There was no statistically significant relationship between gender and cardiovascular endurance, based on a correlation value of 0.149 and a significance level of 0.255. Previous research conducted on athletes at the Student Sports Education and Training Center, West Nusa Tenggara, did not show any relationship between gender in VO₂Max, namely the cardiovascular endurance test (Kurniawan et al., 2024). Other studies have also found no evidence of the influence of gender in determining VO₂ max (Achmad, Arsyad, Putra, Sukmana, Adiputro, & Kasab, 2020). The findings of this study confirm other studies by showing that gender does not have a significant effect on

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cardiovascular endurance. In addition, the relationship between age and cardiovascular endurance was also not significant with a significance level of 0.581 and a coefficient value of 0.073. However, other studies have shown a weak but positive relationship between VO₂ max and age (Wulandari, 2023). This study shows that, although cardiovascular endurance increases with age, this relationship is often not statistically significant, particularly for medical students.

The results of the Spearman's rho test showed no significant relationship between cardiovascular endurance and BMI, with a coefficient value of -0.220 and a significance value of 0.091. These results indicate a negative correlation between increasing BMI and decreasing cardiovascular endurance, but the relationship is not statistically significant. This finding is consistent with previous studies which concluded that there is no significant correlation between BMI and VO₂ max in athletes (Kurniawan et al., 2024). However, other studies have shown a strong correlation between BMI and body fat percentage which has a negative impact on VO₂Max, especially in those who are obese (Lestari, Wahyuni, Nugraha, & Tianing, 2020). The difference in results may be due to variations in demographics, measurement techniques, and guidelines used in the study. Therefore, although BMI has the potential to affect cardiovascular endurance, other variables, such as physical activity and body composition, may have a greater impact on cardiovascular fitness.

This study offers several advantages as it specifically assessed the correlation between Body Mass Index (BMI) and cardiovascular endurance. This aspect has not been extensively investigated in previous studies, particularly those conducted in Eastern India or among adolescent cohorts in Brazil (Mukhopadhyay et al., 2021; Deusdará et al., 2022). The Eastern India study examined global cardiovascular disease risk variables and used waist-to-height ratio as a predictor (Mukhopadhyay et al., 2021). In contrast, this study offers more precise insights into the relationship between BMI and cardiovascular endurance, particularly among medical students. In contrast to previous studies that investigated the correlation between cardiovascular fitness, physical activity, and BMI in a cohort of middle-aged adults with cardiovascular risk factors,

this study also presents the following differences (Haapala et al., 2020).

Nevertheless, this study supports previous findings on the relationship between BMI and cardiovascular endurance. BMI can be an important indicator, although not the only one, in assessing cardiovascular risk (Mukhopadhyay et al., 2021). Furthermore, this study emphasizes the importance of more comprehensive measurements, such as waist circumference, in identifying BMI-related risk (Deusdará et al., 2022). This study also supports findings that suggest that positive arterial responses to exercise are more pronounced in fit individuals with normal weight (Haapala et al., 2020). However, this study also suggests that other factors, such as physical activity, may significantly influence cardiovascular endurance, adding a new perspective in the context of the student population.

The implications of this study suggest that although Body Mass Index (BMI) has the potential to be an indicator of cardiovascular endurance risk, other factors, such as physical activity levels, also play an important role that should not be overlooked. The finding that most respondents with normal BMI still have poor cardiovascular endurance, suggests the importance of a holistic approach to assessing cardiovascular fitness, where BMI measurement needs to be complemented with evaluation of physical activity and other factors that influence overall fitness. In addition, these findings serve as a basis for a more comprehensive health intervention program among medical students with a focus on weight control and increased physical activity and healthy lifestyle habits to improve cardiovascular endurance and prevent future cardiovascular disease risk.

CONCLUSION

BMI, gender, and age did not significantly affect cardiovascular fitness among college students. On the other hand, factors beyond BMI, such as physical activity, play a more important role in determining cardiovascular health, so a holistic approach is needed to improve cardiovascular fitness.

SUGGESTION

Students should do regular physical exercise and maintain normal body weight to maintain cardiovascular endurance in achieving physical fitness. Increase cardiovascular endurance, either

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through consuming healthy and balanced foods or doing regular physical activities such as morning walks, cycling, or heart fitness training. In addition, further researchers can conduct further research on other factors that affect cardiovascular endurance such as fatigue factors and sleep quality.

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