THE ASEAN JOURNAL OF MILITARY AND PREVENTIVE MEDICINE

The Relationship Between Body Composition and 12 Minute Run Test Among Cadet Medical Students in The Undergraduate Medical Program Republic of Indonesia Defense University

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Abstract

Body composition significantly influences physical performance, including running ability. Muscle mass and fat mass are key factors in determining strength, endurance, and efficiency. This study analyzes the relationship between body composition and 12- minute running distance among cadet students in the Undergraduate Medical Program Cohort 4 at the Republic of Indonesia Defense University. This cross-sectional study measured body composition using bioelectrical impedance analysis (BIA) and assessed running performance through a 12-minute run test. Statistical analysis was conducted to evaluate the relationship between muscle mass, fat mass, and running distance. The study found a significant relationship between body composition and running performance. Male participants, with higher muscle mass and lower fat mass, outperformed females in average running distance and maximum distance achieved. Muscle mass and fat mass significantly affect 12-minute running performance, highlighting their importance in designing effective physical training programs. Further research is needed to explore additional factors influencing physical performance.

Keyword: Body Composition, Running Performance, Muscle Mass, Fat Mass, Physical Fitness

Introduction

Physical fitness is the body's ability to perform physical activity efficiently without experiencing excessive fatigue. A good level of physical fitness has many health benefits, including lowering the risk of chronic diseases such as heart disease, diabetes, and hypertension (1). According to Guyton and Hall (2016), individuals with good physical fitness tend to be more productive and able to adapt to various physical and mental stressors (2).

Based on the 2021 Sport Development Index report, the level of physical fitness in Indonesia still needs to be improved. Data analysis shows that the "very poor" category has the highest percentage (53.63%), while the "very good" and "excellent" categories are only 5.86% (3). This shows that most people have not reached optimal fitness levels. Physical fitness is an important aspect for Defense University cadets because they undergo various physical activities during their education. One of the benchmarks used is a physical fitness test, including a 12-minute running test that is carried out regularly. However, the results of the evaluation showed that there was considerable variation among student cadets, which indicated that there were other factors that affected their performance (4).

Body composition, specifically muscle mass and fat mass, play an important role in

physical fitness. High muscle mass supports power production during running, while excess fat mass increases metabolic load without contributing to physical performance. Subcutaneous fat can also inhibit heat dissipation, thereby increasing the body's core temperature and accelerating fatigue (5). Previous research has shown that individuals with a higher proportion of muscle mass have better physical endurance than those with excess fat mass (6). Another study on hockey athletes at Yogyakarta State University found that 52.8% of physical fitness levels are influenced by body fat, while the rest are influenced by other factors such as muscle mass and training duration (7).

Although various studies have been conducted, studies on the relationship between body composition and the results of a 12-minute run in cadets of Defense University students are still limited. Medical students at this university have varying levels of physical activity due to high academic demands, which can affect their body composition and physical fitness (8). Therefore, this study aims to analyze the relationship between body composition, especially muscle mass and fat mass, with the results of a 12-minute running test in cadets of students of the medical study program of the Defense University of the Republic of Indonesia.

The results of this study are expected to provide insight into the importance of ideal body composition in supporting physical fitness, and can be the basis for the development of a more effective physical exercise program for medical students at the Defense University.

Methods

This study uses a quantitative method with an observational analytical design and a cross-sectional study approach. The research was carried out in the integrated laboratory of the Defense University from May to July 2024, with data collection at the Laboratory of the Defense University of the Republic of Indonesia. The research population is cadets of medical study program cohort 4 of the Defense University who actively participate in the physical equality program. The total sampling technique was used because the population was less than 100 people, so 75 subjects were obtained as research samples.

The inclusion criteria in this study included student cadets at least 18 years old who were willing to participate by signing informed consent. Exclusion criteria include subjects with a history of lower extremity injury, use of medications that affect heart function, or have chronic diseases that interfere with physical fitness. Subjects who did not complete the questionnaire or were unable to take the 12-minute running test were categorized as drop-outs.

Data collection was carried out through body composition measurements using Bioimpedance Analysis (BIA) and the results of a 12-minute running test from physical fitness data for the even semester of 2024. In addition, questionnaires are used to collect demographic data and health history. The independent variables in this study were muscle mass and fat mass, while the bound variable was the result of a 12- minute running test measured based on distance traveled in meters.

The data obtained was analyzed using SPSS version 25.0 with a normality test to determine the distribution of data. Univariate analysis was performed to describe the characteristics of the subjects, while the relationship between body composition and the results of the 12-minute run was analyzed using a simple regression test to determine the influence of the independent variable on the bound variable. This research has received approval from the Health Research Ethics Committee of the Defense University with registration number XXX/2024.

Results

This study involved 72 student cadets, with the majority being female (54.2%) and in the age range of 18-20 years. The characteristics of the subjects showed that the average muscle mass was 43.5% and the fat mass was 21.6%, while the average distance traveled in the 12-

minute running test was 2376 meters. The difference in body composition between men and women is obvious, where men have higher muscle mass, while women have higher fat mass. This is also in line with the finding that the average running distance is higher in men than in women, indicating a relationship between body composition and the outcome of a 12-minute run.

Table 1. Characteristic and Distribution of Data

Gender	Frequency	Percentage	Average Muscle Mass (%)	Highest Muscle Mass (%)	Lowest MuscleMass (%)	Average Fat Mass (%)	Highest Fat Mass (%)	Lowest Fat Mass (%)
Male	33	45,8	48,2	53,3	44,1	14,5	21,4	6,9
Female	39	54,2	39,5	44,4	33,8	27,7	37,5	18,8
Total	72	100	43,5	53,3	33,8	21,6	37,5	6,9

In this study, data analysis began with a normality test using the Kolmogorov- Smirnov test, conducted on the variables muscle mass and fat mass against the 12- minute run distance. This test aimed to determine whether the residual data of these variables followed a normal distribution. The results showed that the sample size (N) was 72, with Kolmogorov-Smirnov test statistics of 0.080 for muscle mass and 0.085 for fat mass. The Asymp. Sig. (2-tailed) value was 0.200, which is greater than the significance level of 0.05, indicating that the data were normally distributed. Therefore, the analysis proceeded using simple linear regression.

The simple linear regression test was conducted to analyze the relationship between muscle mass and fat mass with the 12-minute run distance. The results showed a very strong positive correlation between muscle mass and running distance ($R = 0.841$, $R^2 = 70.8\%$, $p < 0.05$), meaning that an increase in muscle mass was directly proportional to an increase in running distance. Each 1% increase in muscle mass was estimated to improve the average running distance by 59.560 meters. Conversely, fat mass had a very strong negative correlation with running distance ($R = 0.821$, $R^2 = 67.4\%$, $p < 0.05$), indicating that higher fat mass resulted in a shorter running distance. Each 1% increase in fat mass was estimated to reduce the average running distance by 37.222 meters.

The analysis based on gender differences showed significant relationships in both groups. Among male participants, muscle mass had a moderately strong positive relationship with running distance ($R = 0.443$, $R^2 = 19.6\%$, $p < 0.05$), with each 1% increase in muscle mass improving the average running distance by 29.241 meters. In contrast, fat mass had a significant negative effect on running distance ($R = 0.444$, $R^2 = 19.7\%$, $p < 0.05$), where each 1% increase in fat mass led to a decrease of 17.767 meters in running distance.

Among female participants, the relationship between muscle mass and running distance was also significant but weaker than in males ($R = 0.427$, $R^2 = 18.2\%$, $p < 0.05$), with each 1% increase in muscle mass improving the average running distance by 24.602 meters. Similarly, fat mass had a negative correlation with running distance ($R = 0.414$, $R^2 = 17.1\%$, $p < 0.05$), where each 1% increase in fat mass led to a decrease of 13.442 meters in running distance.

Overall, the findings of this study indicate that muscle mass positively contributes to 12-minute run performance, while fat mass negatively affects it. This effect is consistent for both males and females, although the relationship is generally stronger in males than in females. The visual representation of the regression results further supports these findings, showing a trend of increased running distance with higher muscle mass and decreased running distance with higher fat mass, reinforcing the significance of the obtained regression values.

Table 2. Result of Simple Regresion Linear Test

Gender	Frequency	Variable	Significance	R	R Square	Regression Coefficient
Male & Female	72	Muscle Mass (%)	0,000	0,841	70,8%	59,560
		Fat Mass (%)	0,000	0,821	67,4%	-37,222
Male	33	Muscle Mass (%)	0,016	0,443	19,6%	29,241
		Fat Mass (%)	0,016	0,444	19,7%	-17,767
Female	39	Muscle Mass (%)	0,007	0,427	18,2%	24,602
		Fat Mass	0,009	0,414	17,1%	-13,442

Discussion

This study demonstrates a significant relationship between body composition, specifically muscle mass and fat mass, and the 12-minute run test performance among cadet students at the Republic of Indonesia Defense University. The analysis reveals that muscle mass positively contributes to running performance, whereas fat mass negatively impacts it. Male cadets, who generally have higher muscle mass, covered greater running distances than female cadets, who exhibited higher fat mass percentages. These findings align with previous research indicating that individuals with higher fitness levels tend to have greater muscle mass and lower body fat percentages, contributing to improved biomechanical efficiency and endurance performance (7,9).

Physiologically, muscle mass plays a crucial role in enhancing aerobic endurance and energy efficiency during running. A higher muscle mass is associated with an increased number and size of mitochondria, enabling more efficient ATP production through oxidative phosphorylation (10). In contrast, higher fat mass increases body load, forcing muscles to exert more effort to move the body, thereby elevating energy consumption per step and accelerating fatigue (11) Additionally, subcutaneous fat can hinder heat dissipation, leading to higher core body temperatures and greater reliance on thermoregulatory mechanisms such as increased sweating and blood flow to the skin, which further reduces energy efficiency during running (11)

Differences in fat distribution between males and females also contribute to variations in running performance. Males tend to store fat in visceral areas, whereas females have more subcutaneous fat, particularly around the hips and thighs, which may create additional biomechanical resistance during running (12). Interestingly, five male participants in this study exhibited higher fat mass than female participants but still achieved longer running distances. This can be attributed to the different effects of visceral fat in males, which is metabolically more active and has less biomechanical impact than subcutaneous fat, which is predominant in females. Additionally, one female participant with muscle mass comparable to male participants recorded a lower running distance, which may be explained by differences in muscle fiber composition, as males generally possess a higher proportion of type II muscle fibers, which are advantageous for strength and speed (12).

Beyond body composition, hormonal differences significantly influence muscle and fat mass. Testosterone, which is higher in males, promotes muscle protein synthesis, inhibits muscle protein breakdown, and enhances lipolytic enzyme activity, such as hormone-sensitive

lipase (HSL), accelerating fat breakdown (13,14). Conversely, estrogen, which is dominant in females, promotes fat storage, particularly in the gluteofemoral region, through the activation of estrogen receptors (ERα and ERβ), which enhance subcutaneous fat deposition while suppressing visceral fat accumulation (15) Consequently, females naturally have a higher fat percentage than males, which contributes to the observed differences in physical performance.

In addition to body composition and hormonal factors, several other variables influence running performance differences between males and females. One key factor is maximal aerobic capacity (VO2Max), which is typically higher in males and contributes to superior endurance performance. Psychological factors such as motivation and mental resilience also play a role in determining the running distance an individual can achieve. Furthermore, anthropometric characteristics, such as leg length, can affect running efficiency, as individuals with longer legs tend to exhibit better biomechanical efficiency and greater stride length, allowing them to cover longer distances with fewer steps (16).

Overall, this study highlights the crucial role of body composition, particularly muscle mass and fat mass, in determining 12-minute run performance. Males, with greater muscle mass and lower fat percentages, tend to perform better in endurance running tests. However, physiological differences, including fat distribution, muscle fiber composition, VO2Max, psychological resilience, and anthropometric traits, also contribute to these outcomes. These findings underscore the importance of body composition management in optimizing physical performance, particularly for individuals undergoing structured fitness or athletic training programs.

Conclusion

The results of this study indicate a significant difference in the average muscle mass and average fat mass between male and female cadet students. Based on Bioimpedance Analysis (BIA), males have a higher average muscle mass, whereas females have a higher average fat mass. This difference reflects biological factors that influence physical capacity and athletic performance. In the 12-minute run test, male cadets consistently covered a greater running distance than female cadets. This suggests that they have better physical endurance, which can be attributed to their higher average muscle mass. Conversely, female cadets demonstrated shorter running distances, likely due to their higher average fat mass, which increases body load and reduces biomechanical efficiency during running.

Furthermore, this study found a significant relationship between body composition and running performance. Average muscle mass has a positive correlation with running distance, where individuals with higher average muscle mass tend to cover longer distances in the 12-minute run test. On the other hand, average fat mass has a negative correlation with running performance, as an increase in average fat mass tends to decrease endurance and running efficiency. These findings emphasize that the balance between muscle mass and fat mass is a key factor in determining physical performance.

Based on these results, it is recommended that physical training programs be tailored to individual body composition, focusing on increasing average muscle mass and managing average fat mass to support running performance. Regular monitoring of body composition, particularly average muscle mass and average fat mass, is essential to maintain optimal body balance. Additionally, a more personalized training approach and education on proper nutrition can help students achieve an ideal body composition. Further research, incorporating additional variables such as health conditions and exercise habits, is necessary to deepen the understanding of the relationship between body composition and physical performance.

References

1. Basic Concepts of Physical Activity and Fitness Definition of Fitness and Its Components.

2. Hall JE, Hall ME. Guyton and Hall textbook of medical physiology. 14th ed. Philadelphia: Elsevier; 2021.
3. Mutohir TC, Lutan R, Maksum A, Kristiyanto A, Akbar R. Laporan Nasional Sport Development Index Tahun 2021. Kementerian Pemuda dan Olahraga Republik Indonesia [Internet]. 2021;1–126. Available from: https://deputi3.kemenpora.go.id/dokumen/30/laporan-nasional-sport- development-index-tahun-2021
4. Kochman M, Kasperek W, Guzik A, Drużbicki M. Body Composition and Physical Fitness: Does This Relationship Change in 4 Years in Young Adults? Int J Environ Res Public Health. 2022;19(3).
5. Duda K, Majerczak J, Nieckarz Z, Heymsfield SB, Zoladz JA. Human Body Composition and Muscle Mass. Muscle and Exercise Physiology. 2018;3–26.
6. Leituhai W, Silva AF, Georgia B, Clemente FM, Carvutto R, Yunani G, et al. Interaksi Komposisi Tubuh dengan Kebugaran Jasmani: Studi Cross-Sectional pada Pemain Sepak Bola Remaja. 2022;4–6.
7. Latifah NN, Margawati A, Rahadiyanti A. Hubungan komposisi tubuh dengan kesegaran jasmani pada atlet hockey. Jurnal Keolahragaan. 2019;7(2):146–54.
8. Li B, Sun L, Yu Y, Xin H, Zhang H, Liu J, et al. Associations between body composition and physical fitness among Chinese medical students: a cross- sectional study. BMC Public Health. 2022;22(1):1–9.
9. Rohendi A, Rustiawan H, Maryati S. Hubungan Persentase Lemak Tubuh Terhadap Tingkat Kebugaran Jasmani. Jurnal Wahana Pendidikan. 2020;7(1):1.
10. Bigard X. Chapter 4 - Adaptation of Skeletal Muscle Mass and Metabolism to Physical Exercise. In: Walrand SBTN and SM, editor. Academic Press; 2019. p. 47–61. Available from: https://www.sciencedirect.com/science/article/pii/B978012810422400004X
11. Brownstein AJ, Veliova M, Perez RA, Liesa M, Shirihai S. Siklus sia-sia yang mengonsumsi ATP sebagai mekanisme pembuangan energi untuk melawan obesitas. 2022;121–31.
12. Engelbrecht L, Rawlins ÃM, Kohn ÃTA, Wilson RL, Eksteen GJ, Myburgh KH. Sex Differences in the Response to Exercise Training Physiological and muscle histochemical assessment of men and women 10 km runners matched for race performance or training volume. 2024;(January):1133–43.
13. Wolfe R, Ferrando A, Sheffield-Moore M, Urban R. Testosterone and muscle protein metabolism. Mayo Clin Proc [Internet]. 2000;75(SUPPL.):S55–60. Available from: http://dx.doi.org/10.1016/S0025-6196(19)30644-5
14. Blouin K, Boivin A, Tchernof A. Androgens and body fat distribution. J Steroid Biochem Mol Biol [Internet]. 2008;108(3):272–80. Available from: https://www.sciencedirect.com/science/article/pii/S0960076007002439
15. Bjune JI, Strømland PP, Jersin RÅ, Mellgren G, Dankel SN. Metabolic and Epigenetic Regulation by Estrogen in Adipocytes. Front Endocrinol (Lausanne) [Internet]. 2022;13. Available from: https://www.frontiersin.org/journals/endocrinology/articles/10.3389/fendo.2022. 828780
16. Pokhariyal GP. Review of factors determining performance in long distance running. International Journal of Statistics and Applied Mathematics. 2023;8(3):84–8.