



## 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

**Background:** Body composition influences physical performance, including running ability. Muscle mass and fat mass are important determinants of strength, endurance, and movement efficiency. This study analyzed the relationship between body composition and 12-minute running distance among cadet medical students. **Methods:** This quantitative observational analytic study used a cross-sectional design. Cadet medical students from Cohort 4 of the Republic of Indonesia Defense University were recruited. Body composition was measured using bioelectrical impedance analysis, and running performance was assessed with a 12-minute run test. Associations between muscle mass, fat mass, and running distance were analyzed using simple linear regression. **Results:** Seventy-two cadets were included. The mean muscle mass was 43.5%, mean fat mass was 21.6%, and mean 12-minute running distance was 2376 m. Muscle mass showed a strong positive correlation with running distance, whereas fat mass showed a strong negative correlation. Male cadets had higher muscle mass and achieved longer running distances than female cadets. **Conclusion:** Body composition is significantly associated with 12-minute running performance. Higher muscle mass supports better running distance, whereas higher fat mass reduces running efficiency. Individualized training and nutritional strategies should consider body composition to optimize cadet fitness.

**Keywords:** *body composition; cadets; fat mass; muscle mass; running performance*

### Background

Physical fitness is the ability to perform physical activity efficiently without excessive fatigue. Good physical fitness is associated with lower risk of chronic diseases, improved productivity, and better adaptation to physical and mental stressors.<sup>1-2</sup> Data from the Sport Development Index in Indonesia indicate that population fitness still requires improvement, with a large proportion categorized as having very poor fitness.<sup>3</sup>

Physical fitness is particularly important for Defense University cadets because they undergo structured physical activities during education. The 12-minute run test is commonly used as one benchmark of cardiorespiratory endurance. However, variation in performance suggests that individual factors,

including body composition, may influence outcomes.

Body composition, especially muscle mass and fat mass, contributes to running performance. Higher muscle mass supports power production and endurance, whereas excess fat mass increases metabolic load without contributing to propulsion and may accelerate fatigue.<sup>4-9</sup> This study aimed to analyze the relationship between body composition and 12-minute running performance among cadet medical students at the Republic of Indonesia Defense University.

### Methods

This study used a quantitative observational analytic method with a cross-sectional design. The study was

conducted in the Integrated Laboratory of the Defense University from May to July 2024. The population consisted of Cohort 4 medical cadets at the Republic of Indonesia Defense University who actively participated in the physical fitness program. Total sampling was used because the population was less than 100, resulting in 75 potential participants.

Inclusion criteria were cadets aged at least 18 years who provided informed consent. Exclusion criteria were history of lower-extremity injury, use of medications affecting heart function, chronic disease interfering with physical fitness, incomplete questionnaire data, or inability to complete the 12-minute run test. Seventy-two cadets were included in the final analysis.

Body composition was measured using bioelectrical impedance analysis. Variables included muscle mass percentage and fat mass percentage. Running performance was measured using the 12-minute run test and expressed as distance in meters.

Demographic and health-history data were collected through questionnaires.

Data were analyzed using SPSS version 25.0. Normality was assessed using the Kolmogorov-Smirnov test. Univariate analysis described subject characteristics. The relationship between body composition and 12-minute running distance was analyzed using simple linear regression. The study received ethics approval from the Health Research Ethics Committee of the Defense University (XXX/2024).

## Results

This study involved 72 cadets, of whom 33 (45.8%) were male and 39 (54.2%) were female. The average muscle mass was 43.5%, the average fat mass was 21.6%, and the average 12-minute run distance was 2376 m. Male cadets had higher average muscle mass, while female cadets had higher average fat mass.

**Table 1. Characteristics and distribution of body composition data**

Gender	Frequency	Percentage	Average muscle mass (%)	Highest muscle mass (%)	Lowest muscle mass (%)	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

Normality testing showed that residual data for muscle mass and fat mass against 12-minute run distance were normally distributed (Kolmogorov-Smirnov statistic 0.080 for muscle mass and 0.085 for fat mass; Asymp. Sig. = 0.200). Therefore, simple linear regression was performed.

**Table 2. Relationship between body composition and 12-minute running distance**

Group	n	Variable	p-value	R	R square	Regression coefficient
Male and female	72	Muscle mass (%)	0.000	0.841	70.8%	59.560
Male and female	72	Fat mass (%)	0.000	0.821	67.4%	-37.222
Male	33	Muscle mass (%)	0.016	0.443	19.6%	29.241
Male	33	Fat mass (%)	0.016	0.444	19.7%	-17.767
Female	39	Muscle mass (%)	0.007	0.427	18.2%	24.602
Female	39	Fat mass (%)	0.009	0.414	17.1%	-13.442

Muscle mass had a strong positive correlation with 12-minute running distance ( $R = 0.841$ ;  $R$  square = 70.8%;  $p < 0.05$ ), indicating that each 1% increase in muscle mass was associated with an estimated 59.560-m increase in running distance. Fat mass had a strong negative correlation with running distance ( $R = 0.821$ ;  $R$  square = 67.4%;  $p < 0.05$ ), indicating that each 1% increase in fat mass was associated with an estimated 37.222-m decrease in running distance.

## Discussion

This study demonstrated a significant relationship between body composition and 12-minute run performance among cadet medical students. Muscle mass positively contributed to running distance, whereas fat mass had a negative association. These findings are consistent with previous evidence showing that higher muscle mass and lower fat mass improve biomechanical efficiency and endurance capacity [4-9].

Physiologically, muscle mass supports aerobic endurance through improved force production and more efficient oxidative metabolism. Higher muscle mass is associated with increased mitochondrial capacity and ATP production during physical exercise [10]. In contrast, higher fat mass increases body load and may reduce running economy, requiring greater energy expenditure for the same distance [11].

Sex differences may contribute to the observed performance variation. Male cadets generally had higher muscle mass and lower fat mass, whereas female cadets had higher gluteofemoral subcutaneous fat, which may increase biomechanical load during running. Hormonal factors, including testosterone and estrogen, influence muscle protein synthesis, fat distribution, and metabolic responses to training [13-15]. Other factors such as VO<sub>2</sub>max, motivation, mental resilience, leg length, and training history may also affect running performance [16].

## Conclusion

There was a significant relationship between body composition and 12-minute running performance among cadet medical students. Higher muscle mass was positively associated with longer running distance, whereas higher fat mass was negatively associated with running distance. Physical training programs should be individualized based on body composition, with emphasis on increasing muscle mass, managing fat mass, and providing nutrition and exercise education to optimize cadet physical performance.

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## Conflict of Interest

The authors declare no conflict of interest.

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## Author Contributions

All authors contributed to study conception and design, data collection, data analysis, interpretation of results, manuscript preparation, and final approval of the manuscript.

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