Relationship of Body Mass Index-For-Age to Body Fat Percentage Using Relative Fat Mass in Teenagers in Surakarta

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Abstract

Adolescence is a period of rapid growth and physical, psychosocial, and cognitive changes, which can influence nutritional needs. Adolescent groups are one of the leading health concerns because of their unhealthy lifestyles compared to other age groups. One of the problems facing young people is related to weight, such as underweight, overweight, and obesity. This study aims to determine the relationship between the body mass index for age (BMI-for-age) and the percentage of body fat using relative fat mass (RFM) in adolescents in Surakarta. The research method used is quantitative research with a cross-sectional design. The total number of respondents was 117, consisting of 40 males and 77 females. BMI-for-age measurements include age, height, and weight in the formula. Body fat percentages are measured using the Relative Fat Mass (RFM), and body height and waist circumference measurements are included in the form. Spearman's rank test results showed a significant relationship between BMI-for-age and body fat percentage ($p<0.05$), with a positive correlation. The conclusion is that there is a relationship between body mass index according to age and percent body fat using relative fat mass in adolescents in Surakarta.

Keywords: BMI-for-age, RFM, Teenagers

Introduction

Adolescents are the most susceptible to nutritional problems, as adolescents experience rapid physical, psychosocial, and cognitive changes and growth compared to the previous age group (Hardinsyah & Supariasa, 2017). Teenagers between the ages of 15 and 19 are more susceptible to obesity (Jebeile *et al.*, 2022) and other nutritional problems due to excessive eating. Obesity can occur when energy consumption exceeds energy use over a long period (Lin & Li, 2021), as shown by the increase in Body Mass Index-for-age (BMI-for-age) of teenagers. The prevalence of obesity between the ages of 16-18 in Surakarta City is the highest in the city or district, with the highest prevalence of obesity rates in Central Java, with 9.98% overweight and 11.47% obese (Riskesdas, 2018).

Obesity that lasts until adulthood can increase the risk of cardiovascular disease (Powell-Wiley *et al.*, 2021). Genetic factors, environmental factors, high fat consumption, and high levels of spontaneous activity in adolescents are the main factors in obesity (Puspitasari *et al.*, 2019). Overweight or obesity prevention interventions have always focused on behavioral modification, such as increasing daily physical activity or improving the quality of a diet by limiting calorie intake (Kansra *et al.*, 2021).

One of the prevention strategies for obesity is the screening of people with measurements of BMI-for-age and body fat percentage (Yao, 2013). Relative Fat Mass (RFM) is a method to calculate the percentage of body fat. Scientists at the U.S. Cedars-Sinai Medical Center in California invented this measurement method. This measurement method puts a person's height and waist circumference into the formula, approximately equivalent to their body fat percentage. RFM can estimate body fat percent and diagnose overweight or obesity in teenagers aged 15 to 19 (Woolcott & Bergman, 2018). Research has shown that using RFM is more practical in measuring fat mass in obese individuals (Woolcott & Seuring, 2022). This study aimed to determine the relationship between the body mass index-for-age (BMI-for-age) and the percentage of body fat using relative fat mass (RFM).

Methods

This research method is descriptive with a cross-sectional study design. This study was conducted in 4 schools in Surakarta City, namely State Senior High School 4 Surakarta, State Senior High School 5 Surakarta, Al-Abidin Bilingual Boarding School Surakarta, and State Vocational High School 9 Surakarta, which was conducted in July 2023, with inclusion criteria for research subjects in grades X-XI, age 15-18 years, attending school and living in the city of Surakarta. Exclusion criteria for adolescents who use appetite suppressants. Determination of the minimum sample size using the calculation formula of Slovin (1960) is:

$$n \quad = N / (1 + N \times e2)$$
$$= 41093 / (1 + 41093 \times 0.12)$$
$$= 41093 / 411.93$$
$$= 99.75 = 100 \text{ respondents}$$

An estimate of a 15% loss to follow-up is:

n = 100 + (100 x 15%)

  = 115 respondents

N: Population size / total population in Surakarta aged 15-19 years of 41093 people

n: Number of samples

e: margin of error (error tolerance) 10% or 0.1(Badan *et al.,* 2021).

The Number of respondents for each school using the formula according to Sugiyono (2007) is n = (x / N) N1

n = Number of desired samples per stratum

N = Total population of teenagers in the School

X = Total population in each stratum

N1 = Sample

Based on the formula, the number of respondents from each school is State Senior High School 4 Surakarta = 1134/4876 x 115 = 26.7 = 27 respondents, State Senior High School 5 Surakarta = 1054/4876 x 115 = 24.8 = 25 respondents, Al-Abidin Bilingual Boarding School Surakarta = 1054/4876 x 115 = 26.1 = 27 respondents, State Vocational High School 9 Surakarta = 1581/4876 x 115 = 37.2 = 38 respondents. The total sample size is 117 adolescents.
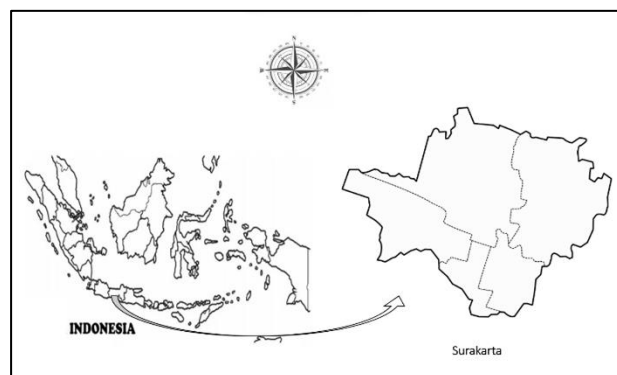
Figure 1. Location of research in Surakarta City at four schools, State Senior High School 4 Surakarta (7°33'22.4"S 110°48'07.7"E), State Senior High School 5 Surakarta (7°33'00.8"S 110°49'50.3"E), Al-Abidin Bilingual Boarding School Surakarta (7°32'16.8"S 110°48'22.7"E), and State Vocational High School 9 Surakarta (7°32'05.0"S 110°48'15.5"E)

This study has received ethical approval from the Health Research Ethics Committee (KEPK) of the Faculty of Medicine, Sebelas Maret University, with the number 95/UN27.06.11/KEP/EC/2023. The data were primary, including body weight using a weight scale, height using a microtome, and waist circumference using a midline to determine BMI/U and RFM values. Statistical tests to determine the relationship between variables used the Person Product Moment test if the data is normally distributed. If the data is not normally distributed, use the *Spearman rank* test.

Results and Discussions

The research results in **Table 1** show that women dominate the characteristics of the gender research subjects compared to men, which is due to the higher number of female students than men. Based on BMI-for-age, most subjects were in the normal category, with 76 (65%) people, while the lowest was fewer than 10 (8.5%). In the percentage category of body fat using RFM, most samples were found at the height of 46 (39.3) people.

Table 1. Characteristics and distribution of samples based on variables studied

Category	n	%
Gender type		
Male	40	34.2
Female	77	65.8

BMI-FOR-AGE		
Poor nutrition	10	8.5
Normal nutrition	76	65.0
Overnutrition	20	17.1
Obesity	11	9.4
Body Fat Percentage (RFM)		
Fitness	34	29.1
Average	37	31.6
Obese	46	39.3

Table 2 shows the frequency distribution of body mass index according to age (IMT/U) and per cent body fat using RFM. The respondents' IMT/U had a mean value of 3.27, a median of 3.00, a standard deviation of 0.75, a minimum value of 2.00, and a maximum value of 5.00. The respondents' per cent body fat with RFM had a mean value of 1,39, a median of 1,00, a standard deviation of 0.49, a minimum value of 1.00, and a maximum value of 2.00.

Tabel 2. Frequency Distribution of Body Mass Index Respondents by Age and Percent Body Fat Using Relative Fat Mass

	Mean	Median	Std. Deviation	Minimum	Maximum
IMT/U	3.27	3.00	0.75	2.00	5.00
RFM	1.39	1.00	0.49	1.00	2.00

Table 3 shows the correlation test results between variables using the Spearman rank test. Then, the results obtained for the relationship between BMI-for-age and body fat percentage show, among other things, that there is a significant relationship with the result (p=0,000, r=0.628**) where the value of $p<0.05$ indicates that the higher a person's BMI-for-age value, the higher the value of the body fat per cent; otherwise, the smaller the BMI-for-age value, the lower the per cent of body fat. This research succeeded in observing the relationship between both.

The results of this study are in line with previous studies, which stated that there was a relationship between body fat percentage and BMI (Akindele *et al.*, 2016). The study conducted by Naulia *et al.* (2023) showed a significant relationship between BMI and body fat percentage ($p<0.05$) with a positive direction. Another study with the same variable found a correlation between BMI and body fat percentage (p = 0,000) with a sample size of 115 people meeting the productive age criteria (15–64 years), a study conducted in Semarang (Susantini, 2021). Similarly, a study conducted on medical students at Diponegoro University resulted in a positive correlation between BMI and individual body fat percentage, with an average fat content of 72.5% in the sample (Archilona *et al.*, 2016).

To the author, this is the first study to address the relationship between BMI and RFM. The study results show that there is a relationship between BMI/U and RFM. The results of this study are in line with previous studies, which stated that there was a relationship between BMI and the per cent body fat of adult women estimated by BIA (Misra *et al.*, 2019). Other supporting studies show that RFM has high accuracy in estimating body fat percentage (Paek *et al.*, 2019). RFM predicts the proportion of body fat more accurately (Woolcott & Bergman, 2018), so it can easily estimate adiposity in individuals (Corrêa *et al.*, 2021). RFM is a simple-to-calculate, sex-specific obesity indicator more closely approximates whole-body fat percentage than BMI (Suthahar *et al.*, 2023). The reference explains that separately, RFM is more accurate in predicting per cent fat than BMI in obese individuals (Paek *et al.*, 2019).

Obesity is the accumulation of excess fat that can be detrimental to health. Obesity results from an imbalance between energy consumed and energy spent (Jehan *et al.*, 2020). Increased consumption of high-energy foods such as fat and sugar can lead to an increase in body fat percentage (WHO, 2021). The gradual and periodic measurement of anthropometry is one of the methods of preventing obesity. Anthropometric measurement methods include the calculation of age-based body mass index (BMI-for-age), upper arm circumference (LILA), neck circle, waist-to-arm circle comparison (RLPP), and skin fold thickness (SKF), bioelectric impedance analysis (BIA) and double-energy x-ray absorption (DXA) (Supariasa *et al.*, 2016).

The advantage of RFM in measuring body fat percentage is that it is a simple, inexpensive, and non-invasive technique (Corrêa *et al.*, 2021). Thus, its use is more popular. It is known that BMI is correlated with body fat mass (Jeong *et al.*, 2023). One study determined that the body mass index (BMI) correlates strongly with the body fat mass

determined by the bioelectrical impedance analysis (BIA) method. Still, the BIA method is superior to the BMI method in determining body mass composition (Wiranata & Inayah, 2020).

A study stated that a person who followed nutrition counselling experienced a decrease in the percentage of overweight women's body fat and obesity among Pilates gym participants (Ranitadewi *et al.*, 2018). Therefore, it is essential to note the importance of keeping the body mass index according to age in adolescents within the normal range. BMI-for-age is closely linked to total body fat levels, so it can trigger the onset of obesity, which may trigger various fatal diseases. Teenagers who are obese or overweight can be prevented by performing routine measurements of BMI-for-age and body fat percentage.

Conclusions

The study was conducted on adolescents in Surakarta City at State Senior High School 4 Surakarta, State Senior High School 5 Surakarta, Al-Abidin Bilingual Boarding School Surakarta, and State Vocational High School 9 Surakarta with a total sample of 117 people where the majority of the sample was female with a percentage of 65.8%. Based on the results of the Rank Spearman test conducted, the data showed a significant solid relationship with a positive direction between body mass index according to age (IMT/U) and per cent body fat using Relative Fat Mass (RFM) (p=0.000). The results showed that the higher a person's body mass index, the higher the body fat percentage. Therefore, excessive fat accumulation can lead to obesity and hurt health. The results of this study are expected to be a scientific reference in school nutrition programs to determine the nutritional status and percentage of body fat in students using IMT/U and RFM, which are conducted periodically.

Acknowledgments

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