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RELATIVE FAT MASS AND BIOELECTRICAL IMPEDANCE ANALYSIS TO MEASURE BODY FAT PERCENTAGE IN ADOLESCENTS

Relative Fat Mass dan Bioelectrical Impedance Analysis Untuk Pengukuran Persen Lemak Tubuh Pada Remaja

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ABSTRAK

Relative Fat Mass (RFM) adalah metode pengukuran persentase lemak tubuh yang ditemukan oleh para peneliti di Cedars-Sinai Medical Center di California, Amerika Serikat pada tahun 2018 dengan memasukkan tinggi badan dan lingkar pinggang seseorang ke dalam rumus dan dapat digunakan pada remaja usia 15-19 tahun. Bioelectrical impedance analysis (BIA) adalah alat yang menggunakan empat elektroda, dua di antaranya digunakan untuk menghantarkan arus sinusoidal 50 kHz ke tubuh dan sisanya digunakan untuk mengukur tegangan yang dihasilkan oleh tubuh untuk analisis impedansi.Tujuan penelitian ini untuk menganalisis hubungan Relative Fat Mass *(RFM) dan* Bioelectrical Impedance Analysis *(BIA) untuk pengukuran persen lemak tubuh pada remaja. Penelitian yang digunakan merupakan penelitian kuantitatif dengan desain penelitian studi cross-sectional. Jumlah responden sebanyak 117 orang terdiri dari 40 laki-laki dan 77 perempuan. Pengukuran persen lemak tubuh menggunakan* Relative Fat Mass *(RFM) dengan memasukan pengukuran tinggi badan dan lingkar pinggang ke dalam rumus. Pengukuran persen lemak tubuh menggunakan* Bioelectrical Impedance Analysis *(BIA),* body composition monitor, Model HBF-375. *Analisis data menggunakan uji* Rank Spearman. *Penelitian ini menemukan signifikasi* p-value *sebesar 0,000<0,05. Dapat disimpulkan bahwa RFM dan BIA memiliki hubungan yang signifikan terhadap pengukuran persen lemak tubuh remaja. Dengan demikian,* Relative Fat Mass *(RFM) dapat digunakan untuk pengukuran persen lemak tubuh selain menggunakan* Bioelectrical Impedance Analysis *(BIA) pada remaja.*

Kata kunci: *bioelectrical impedance analysis (BIA), relative fat mass (RFM), remaja.*

ABSTRACT

Relative Fat Mass (RFM) is a method of measuring percentage of body fat discovered by researchers at Cedars-Sinai Medical Center in California, United States in 2018 by incorporating a person's height and waist circumference into the formula and can be used in adolescents aged 15-19 years. Bioelectrical impedance analysis (BIA) is a device that uses four electrodes, two of which are used to deliver a 50 kHz sinusoidal current to the body and the rest are used to measure the voltage generated by the body for impedance analysis. The study aimed to analyze the relationship between Relative Fat Mass (RFM) and Bioelectrical Impedance Analysis (BIA) to measure body fat percentage in adolescents. The research used is quantitative research with cross-sectional study research design. The number of respondents was 117 people consisting of 40 males and 77 females. Measure percent body fat using Relative Fat Mass (RFM) by entering height and waist circumference measurements into the formula. Measuring percent body

fat using Bioelectrical Impedance Analysis (BIA), Body Composition Monitor, Model HBF-375. Data analysis was performed using the Spearman rank test. This study found a p-value significance of 0.000 <0.05, which means that Ha was accepted and H0 was rejected. It can be concluded that RFM and BIA have a significant relationship with the measurement of body fat percentage in adolescents. Thus, Relative Fat Mass (RFM) can be used to measure body fat percentage in addition to using Bioelectrical Impedance Analysis (BIA) in adolescents.

Keywords: adolescents, bioelectrical impedance analysis (BIA), relative fat mass (RFM).

INTRODUCTION

Obesity is a common problem among Indonesian adolescents, with a prevalence of 9.5% obese and 4% obese in 16-18 year olds [1]. The prevalence of obesity in 16-18 year olds in Surakarta City is the city/regency with the highest obesity prevalence rate in Central Java at 9.98% obese and 11.47% obese [2]. Obesity can occur when energy intake exceeds energy expenditure over a long period of time [3]. Obesity can occur in adolescents between the ages of 15 and 19 years [4]. Adolescents are an age group that is highly susceptible to nutritional problems because they experience rapid physical, psychosocial, and cognitive changes and growth compared to previous age groups [5].

One strategy to prevent obesity is to monitor body fat reserves and assess the level of obesity in individuals using body fat percentage measurements [6]. A high percentage of body fat can increase the risk of diseases such as obesity, diabetes, heart disease and some cancers [7]. Monitoring body fat percentage can help assess the risk of disease development [7]. One method of measuring body fat percentage is relative fat mass (RFM). Relative Fat Mass (RFM) was developed by scientists at the Cedars-Sinai Medical Center in California. This method of measurement incorporates a person's height and waist circumference into a formula, and the result is roughly equivalent to body fat percentage. RFM can be used to estimate body fat percentage and diagnose overweight or obesity in adolescents between the ages of 15 and 19 [8]. Studies have shown that the use of RFM is more practical for measuring fat mass in obese individuals [9].

In addition to Relative Fat Mass (RFM), the measurement of percent body fat can also use Bioelectrical Impedance Analysis (BIA) is a method of measuring body fat levels by distinguishing fat mass and non-fat mass based on body composition assessment [10]–[12]. BIA uses a weak electric current passed through the body to measure the resistance produced by body tissues. From the resistance measurement, BIA can calculate the percentage of body fat [10], [11]. BIA is a cheap, simple and portable method that can be used in different locations [10]. BIA can be used to calculate an individual's body composition and distinguish between fat mass and lean mass [10]–[12]. BIA can also be used to predict body fat percentage in adolescents and adults [10], [11]. BIA can be performed using commercially available equipment or by designing your own [10]–[12]. Previous studies have highlighted the superiority of RFM as a measure of fat mass, but no one has raised the relationship between RFM and BIA measurements in measuring fat mass in adolescents. To the author's knowledge, this is the first study conducted to determine the relationship the both.

RFM and BIA are both non-invasive methods for estimating percent body fat, which is critical for assessing chronic disease risk. However, it is important to note that although BIA is a convenient method, its performance in the field can vary and its accuracy can be affected by several factors such as hydration status and the BIA scales used [13]. The objective of this study is to analyze the correlation between RFM and BIA for measuring body fat percentage in adolescents.

METHODS

This type of research is descriptive research with a cross sectional study design. The place of this research was conducted in 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 in the adolescent population in July 2023. The sampling technique used was multistage sampling. The number of samples taken was determined using the Slovin formula [14] as the minimum sample determinant, which resulted in 115 subjects with the addition of 15% loss to follow-up. Thus, the number of samples was 117 adolescents. Inclusion criteria for research subjects in grades X-XI, aged 15-18 years, attending school and/or living in the city of Surakarta. Exclusion criteria for adolescents who use appetite suppressants. The independent variable in this study is Relative Fat Mass (RFM) and the dependent variable is Bioelectrical Impedance Analysis (BIA). Measure percent body fat using Relative Fat Mass (RFM) by entering height and waist circumference measurements into the formula. Measuring percent body fat using Bioelectrical Impedance Analysis (BIA), Body Composition Monitor, Model HBF-375. This study received ethical approval from the Health Research Ethics Committee (KEPK) of the Faculty of Medicine, Sebelas Maret University, under number 95/UN27.06.11/KEP/EC/2023. Statistical tests to determine the relationship between variables using the Person Product Moment test if the data is normally distributed. If the data are not normally distributed, the Spearman rank test is used with the Statistical Product and Service Solution (SPSS) program version 16.0 for Windows.

RESULT

Table 1. Characteristics and Distribution Based on The Variables Studied

Categories	n	%
Gender Type		
Female	77	65,8
Male	40	34,2
Age		
15 years	4	3,4
16 years	72	61,5
17 years	36	30,8
18 years	5	4,3
Relative Fat Mass (RFM)		
Normal	72	61,5
Obesity	45	38,5
Bioelectrical Impedance Analysis (BIA)		
Normal	84	71,8
Obesity	33	28,2
Total	117	100

The characteristics of the research subjects in Table 1, gender is dominated by females compared to males, this is due to the number of female students more than males, namely 65.8%. With the most age is 16 years old at 61.5%. Based on RFM and BIA, most subjects fall into the normal category of 67.5% (RFM) and 71.8% (BIA).

Table 2. Frequency Distribution of Relative Fat Mass (RFM) and Bioelectrical Impedance Analysis (BIA)

	Mean	Median	Std. Deviation	Minimum	Maximum
RFM	1,61	2,00	0,49	1,00	2,00
BIA	1,71	2,00	0,45	1,00	2,00

Table 2 shows the frequency distribution of Relative Fat Mass (RFM) and Bioelectrical Impedance Analysis (BIA). Relative Fat Mass (RFM) has a mean of 1.61, median of 2.00, standard deviation of 0.49, minimum of 1.00 and maximum of 2.00. While Bioelectrical Impedance Analysis (BIA) has a mean of 1.71, median of 2.00, standard deviation of 0.45, minimum of 1.00 and maximum of 2.00.

Table 3. Results Of Tests Of Relationships Between Variables

Variables	p value	r
Relative Fat Mass (RFM) and Bioelectrical Impedance Analysis (BIA)	0,000	0,928**

**. Significant Correlation (Spearman Rank Test)
p-value <0.05 is considered significant.

Table 3 shows the results of testing the correlation between variables using Spearman rank test. Then the results for the relationship between Relative Fat Mass (RFM) and Bioelectrical Impedance Analysis (BIA) in adolescents in Surakarta City, including a significant relationship with the results (p=0.000), where the p-value <0.05, which indicates that the higher the RFM value of a person, the higher the BIA value, on the contrary, the lower the RFM value, the lower the BIA value. The correlation coefficient value was 0.928, meaning there was a very strong relationship.

DISCUSSION

The results of the statistical tests conducted by the researchers showed that there is a positive and very strong relationship between Relative Fat Mass (RFM) and Bioelectrical Impedance Analysis (BIA). These results are consistent with previous studies that explain that there is a high correlation between RFM and BIA in estimating body fat percentage [15]. In a similar cross-sectional study, RFM was found to have good accuracy in estimating body fat percentage compared to the body adiposity index (BAI) derived from BIA measurements as the gold standard in type 2 diabetic patients in Ghana [16]. Another study explained that the use of RFM in measuring body fat is superior to having a variability of 8%, after applying the RFM equation and regression to other methods BIA and DXA (Dual-energy X-ray Absorptiometry) the results are almost the same. RFM has a stronger correlation with DXA than with BIA [17].

Bioelectrical impedance analysis (BIA) uses four electrodes, two of which are used to deliver a 50 kHz sine wave current to the body, and the rest are used to measure the voltage generated by the body for impedance analysis. Parameters such as weight, height, age, and gender are processed along with impedance measurements to generate body fat percentage [18]. It's the gold standard measurement of fat mass. Another method of measurement is RFM. The Relative Fat Mass (RFM) is an alternative method developed through simple anthropometric equations to estimate the percent body fat [15]. Although RFM is a simple method, it has high accuracy in estimating adiposity [19].

The relationship established between the two methods, Relative Fat Mass (RFM) and Bioelectrical Impedance Analysis (BIA) in this study is evidence that shows the effectiveness of both methods in estimating body fat percentage. The results of the fat percentage measurements in this study using RFM are directly proportional to the measurements using BIA. RFM is a method with minimal measurement error [20], so it can validly measure percent body fat [21]. Relative fat mass has several advantages, namely RFM can be used in different genders, ages, heights, RFM does not require special tools and can be easily calculated using formulas [22], [23]. Although RFM can provide good results in measuring percent body fat, it has shortcomings in percent body fat in certain areas and cannot distinguish between body fat and muscle mass [22], [24].

Based on these facts, RFM can be used as an alternative measure that is comparable to BIA in measuring percent body fat.

However, BIA is known to be the current gold standard in body fat measurement, along with DXA (dual-energy x-ray absorptiometry) [25]. Compared to DXA, BIA provides a relatively accurate prediction of body fat percentage in individuals with normal, overweight, and obese nutritional status [26].

The advantages of bioelectrical impedance analysis measurement are that it is cheap, simple, and non-invasive, while the disadvantage is that the measurement results may vary depending on the amount of fluid in the body [27]. The advantages of relative fat mass measurement are that it is a simple, inexpensive, and non-invasive method that contributes to the diagnosis of excess body fat [15]. The disadvantages of Relative Fat Mass are that it requires further validation, relies on waist circumference measurements, and has not been widely clinically tested in different populations [21].

CONCLUSION

In conclusion, this study has reported evidence that there was a strong, significant relationship between Relative Fat Mass (RFM) and Bioelectrical Impedance Analysis (BIA) for measuring body fat percentage in adolescents. Thus, RFM can be used as an alternative to measuring body fat percentage in adolescents.

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