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Comparison of Skinfold Thickness Measurement and Bioelectrical Impedance Method for Assessment of Body Fat

Pradeep Singh Chahar

Manipal University, Jaipur (Rajasthan), India

Abstract: The purpose of this study was to compare the body fat percentage using two different methods of fat assessment like skinfold thickness measurement and bioelectrical impedance. A total of thirty healthy male with age ranges 26 to 49 years were selected as a subject. Predicted percentage body fat (%BF) was derived from skinfold equation given by Durnin and Womersley and bioelectrical impedance by Maltron BF 908 body composition analyzer. Correlation coefficients results showed that there was a good relationship between these two different methods for fat assessment ($r = .667$). The mean body fat percentage determined by bioelectrical impedance was significantly lower than that measured by skinfold thickness measurement. Results revealed significant difference among skinfold thickness measurement and bioelectrical impedance method ($t = 13.100$; $p < .001$). Therefore, it may be concluded that as compare to bioelectrical impedance analysis, skinfold thickness measurement overestimated body fat percentages within a normal subjects although there was a good correlation exist between these two methods.

Key words: Body Fat Percentage · Skinfold Thickness Measurements · Bioelectrical Impedance Analysis (BIA)

INTRODUCTION

The growing popularity of physical activity for enhancing health and fitness has sharpened the health care professional's perspective on techniques for evaluating body composition. Health care professionals require accurate measurements of body in order to advise patients the desirable body weights and for optimal health [1].

Preventing and managing overweight and obesity are complex problems, with no easy answers. Numerous methods for estimating these figures are available and each has its own limitation, be it technical or biological. Quantification of body fat is needed not only for studies of the nature and treatment of obesity, but also for a variety of investigations that range from the assessment of nutritional status to the determination of the nature of the response of patients to a variety of diseases and metabolic disorders. Body fat mass is the difference between total body mass and FFM or LBM [2].

Body fat assessment is an important tool for fitness professionals and can provide an indicator of health and health risk. The determination of the percentage of body fat (% Fat) has gained increasing emphasis as a factor in physical fitness. Obesity and overweight have been associated with the susceptibility to cardiovascular disease and the use of% Fat determinations may be useful in estimating more optimal weights for most individuals [3].

Bioelectrical Impedance Analysis (BIA) offers a great potential for noninvasive assessment of body composition because it is safe, portable, easy to use and much cheaper than the previous, Instrumental techniques. From the measurement of reactance and resistance, the total body water (TBW) and Fat Free Mass could be calculated [4] and converted into BF content using a variety of equations [5]. The cheapest and most common methods to assess BF are anthropometric techniques, especially skinfolds thickness measure, which provide an estimate of the subcutaneous fat depot, recalculated for the total Body Fat or Body Density [6].

Question remain unanswered whether skinfolds thickness measurements tends to over- or underestimate percentage of body fat when compared with bioelectric impedance. To answer the above questions, the present study has been formulated to compare measurements of

Corresponding Author: Pradeep Singh Chahar, Manipal University, Jaipur (Rajasthan), India. Line No. 4/170, Birla Nagar Gwalior (M.P.) 474004, India.

body fat percentage (%BF) by using two methods namely Skinfolds Thickness measurements and Bioelectrical Impedance of the healthy subjects.

MATERIALS AND METHODS

A total of thirty (N=30) healthy subjects with age ranges from 26 to 49 years, were selected as a subject for the study from Gwalior. Body fat Percentage was assessed by using skinfold thickness equation and bioelectrical impedance. Predicted percentage body fat (%BF) was derived from skinfold equation given by Durnin and Womersley and bioelectrical impedance by Maltron BF 908 body composition analyzer. Written consent was taken from each subject willing to participate before the start of study. Subjects were free to withdraw their names from study at any time without asking for any reason.

Measurements were made on a single day between 06:30-10:00 AM. Subjects allowed not to eating and drinking up to eight hours before testing and refrained from exercise for at least the previous twelve hours. Skinfold measurements were performed at four sites (biceps, triceps, subscapular and supra-iliac) on the opposite side of the vascular access using the skinfold caliper. Three sets of measurements were averaged for each site. Body density was calculated using the formula of Durnin and Womersley and the percentage of body fat was then calculated by Siri's equation. Impedance method is based on an estimate of total body water which is then used to calculate body fat content. Maltron BF-908 body composition analyzer with a four electrode arrangement that introduces a painless signal into the body was also used to estimate the%BF. This equipment uses the scientific tetrapolar method of four electrodes which are applied to the right side of the body on the hand, wrist, foot and ankle. As all the parameters entered in the machine while resting in supine position with hands and legs slightly apart, Maltron BF-908 was activated. The processing powers of the BF-908 analysed the data and displayed the information within seconds.

The results were expressed as Mean and Standard Deviation. The body fat was measured in kilograms. The measurements obtained by the Skinfold Thickness Measurements (STM) and Bioelectrical Impedance Analysis (BIA) were compared using t-test. In order to evaluate the strength of relationship between STM and BIA method, pearson product moment correlation coefficient test was employed. Agreement between the two methods was shown by plotting the difference in body fat percentage against mean body fat percentage as obtained by two methods Bland and Altman [7] with the help of MedCalc software and SPSS version 19.

RESULTS

The characteristics of the study subjects with the help of descriptive statistics are presented in Table 1. There were total thirty participants included in this study. The mean and standard deviation for age, height and weight of the subjects were 35.17±7.3, 174.49±5.9 and 70.45±8.3 respectively.

The descriptive statistics for the two different body fat measurement methods used in the study are presented in Table 2. The mean and standard deviation values for percentage of body fat by skinfold thickness measurements and bioelectrical impedance for the study group as a whole were 19.95±5.9 and 9.40±4.1 respectively.

Table 3 reveals that there was a significant difference among Skinfold Thickness Measurements (STM) and Bioelectrical Impedance Analysis (BIA) as calculated value of ‘t’ (13.100) was greater than that of tabulated value (2.045) at 0.05 level of significance with 29 degree of freedom.

Table 4 reveals that body fat measurements using skinfold thickness measurements significantly correlated with bioelectrical impedance as calculated value (0.667) of ‘r’ was greater than that of tabulated value (0.361) at 0.05 level of significant with 28 degree of freedom.

Table 1: Subjects’ Characteristics

	N	Mean	Std. Deviation
Age	30	35.17	7.3
Height	30	174.49	5.9
Weight	30	70.45	8.3

Table 2: Body Fat Measurements

Methods of Fat Percentage Assessment	N	Mean	Std. Deviation
Skinfold Thickness Measurements	30	19.95	5.9
Bioelectrical Impedance	30	9.40	4.1

Table 3: Significance of Difference between Two Different Fat Assessment Method

Methods of Fat Percentage Assessment	Mean Difference	Std. Deviation	t	df	Sig.
Skinfold Thickness Measurements Bioelectrical Impedance	10.55	4.4	13.100*	29	.000

*Significant at 0.05 level.

$t_{.05}$ (29) = 2.045

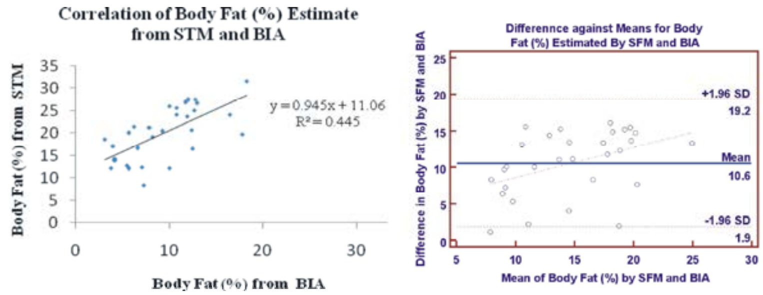

Fig. 1: The correlation of Body Fat Percentage estimated from Skinfold Measurement (STM) and from Bioelectrical Impedance Analysis (BIA) methods of Fat Assessment and the difference in the two estimates plotted against their mean.

Table 4: Correlations of Body Fat Percentage Obtained by Two Different Methods

	Skinfold Thickness	Bioelectrical Impedence
Skinfold Thickness	1	.667*
Bioelectrical Impedence	.667*	1

*Significant at 0.05 level.

$r_{.05}$ (28) = 0.361

DISCUSSION AND CONCLUSION

Body-composition information is extensively used in clinics, sports medicine and other health-related fields [2, 8-12]. Methods such as DXA, air-displacement plethysmography and underwater weighing can provide accurate results; however, these methods are costly and often inaccessible to the public. In most situations, SFM, BIA and other field methods are the only techniques available for body-composition measurements. The results of the present study bridge the gap between previous contradictory studies and provide reliable information on the correct interpretation of body fat percentage analysis.

The statistical finding of the present study revealed that there was a large variation in body fat percentage among two different fat assessment methods. The mean body fat percentage obtained by skinfold thickness measurements in all subjects was significantly higher than that measured by bioelectrical impedance: 19.95±5.9 compared with 9.40±4.1 as shown in Table 2. From this finding, we may conclude that bioelectrical impedance analysis method underestimated the body fat. Table 3 showed that there was a significant difference among Skinfold thickness measurements and bioelectrical impedance analysis for assessing the body fat percentage.

As shown in Table 4, significant correlation was found between skin fold thickness and bioelectrical impedance, but Gibson [13] underlines that accuracy of the results depends on number and sites of skin folds and variations in the distribution of subcutaneous fat occur with sex, race and age. The findings of this study are also in the line of study conducted by Siqueira Vassimon, H . *et al*. [20], Kamimura *et al*. [21] and Rodrigues, N.C. *et al*. [22].

The Bland and Altman plots showed that the limit of agreement (Mean difference ±1.96 SD), for the comparisons of body fat percentage estimated from the used methods, were large. In case of SFM and BIA the range of limits of agreement was from 19.2 to 1.9 BF% and this was widest range among the methods.

In summary, parallel measurement of body fat percentage by skinfold thickness measurements and bioelectrical impedance showed that both these methods cannot be use an alternative of each other although there was a significant relationship exists. Bioelectrical impedance tends to underestimate body fat in all subjects. This finding is partial consonance of the study done by Chumlea *et al*. [23]. Skinfold thickness measurement is a traditional method of measuring body composition and if this method administered carefully than it should be the easy and reliable measure of fat percentage.

Therefore, from the present observations, it is concluded that both these methods namely Skinfold thickness measurements and bioelectrical impedance analysis significantly differ from each other for assessing the body fat percentage within selected subjects. On the other side, above results revealed moderate limit of agreement though there exists good correlation between these two methods. It means both the methods have different concepts for assessing fat percentage. Each method has its own limitation and applicability, on the basis of their criterion these methods may be executed until it becomes possible to assess accurate methods, as these methods are simple, low-cost, practical, reliable and easy to administer. Furthermore, it may be recommended that another study may be conducted on other sex and group of subjects in order to confirm the findings.

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