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A COMPARISON OF ARM TO LEG BIOELECTRICAL IMPEDANCE AND SKINFOLDS IN ASSESSING BODY FAT IN PROFESSIONAL SOCCER PLAYERS

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ABSTRACT

Introduction: This study compared arm-to-leg bioelectrical impedance analysis (BIA) method and skinfold measurement in estimating the percent body fat (%BF) in male professional soccer players. **Methods:** Twenty eight healthy professional soccer players (aged 27.4 ± 5.3 years; ht 180 ± 7.0 cm; wt 76.6 ± 6.3 kg; and BMI 23.66 ± 1.5) from division one Greek League was assessed. Body composition was determined using seven skinfold measures using the Brozek et al. (1963), predictive equation. BIA measurements were determined using a BC-418 Segmental Body Composition Analyzer. Measurements were scheduled at the same time of the day (8:00-10:00) with the athletes presenting in a fasted state and after a full day rest. **Results:** All subject completed both BIA and skinfold measurements and using a pearson correlation coefficient between methods was $r = 0.56$ ($p < 0.01$). Percent body fat values differed between techniques ($p < 0.001$). BIA overestimated %BF by 27.81%. **Conclusion:** The study demonstrated that the arm-to-leg BIA system does not accurately assess %BF when compared to the skinfold measurement method in soccer players.

Keywords: BC-418 Segmental Body Composition Analyzer; body composition; skinfold; soccer

INTRODUCTION

Professional athletes often check their body composition regularly in order to identify changes that could affect their performance (1). For this reason, various methods have been developed such as the use of skinfold, thickness measurement, bioelectrical impedance analysis (BIA), hydrostatic underwater weighing, and dual energy X-ray absorptiometry (DEXA).

Some of these methods require expensive equipment, and require additional time, and training of examiners. Given these reasons, there is a demand for easy, efficient and inexpensive ways to estimate body composition of athletes. This is particularly of interest when managing groups of individuals (e.g., sports teams). Two such methods are the BIA is and the sum of specific skinfold thicknesses. Each of these methods is based on different principles, and likely contributes to different results.

BIA is a very common method for estimating percent body fat (%BF) (2,3,4,5) because is easy, fast, and safe (6). Using the BIA method the examiner must input patient characteristics into the device then the machine chooses the appropriate equation. In this way the prediction error of this method is approximately 3.5 % (20), similar to the standard error of the skinfold method (3.3 %) (7).

The skinfold thickness measurement method requires cheaper equipment but typically demands more training for the examiners. Inter- and intra-individual variability associated with the selection of skinfold sites, the size/depth of the skinfold measurement, and the time delay in reading the calipers have all been shown to markedly reduce the accuracy of this method (8). However an experienced examiner can reduce this variability and can effectively choose the appropriate equation for estimating the percentage of body fat.

The aim of this study was to compare the arm-to-leg BIA system and a seven skinfold thickness measurement method in estimating the %BF in professional soccer players.

METHODS

Subjects

A sample of 28 male professional soccer players participated in this study. Each subject reported to have participated in at least 3 years at first division of Greek League. Measurements were taken before the preparation period (before the season) and were assessed as part of standard anthropometric testing. The physical characteristics of the subjects are shown in Table 1.

After receiving a detailed explanation of the study's benefits and risks, each subject signed an informed consent document approved by the local ethics committee.

Table 1. Subject characteristics

Variable	Mean ± SD
Age (years)	27.4 ± 5.3
Height (cm)	180 ± 7.0
Weight (kg)	76.6 ± 6.3
BMI	23.66 ± 1.5

BMI-body mass index

Measurement of the percentage of body fat

Skinfold thickness measurement method: Body fat percentage was calculated from seven skinfold measures were made to the nearest 0.5mm (average of 2 measurements of each site) using a Harpenden calliper (John Bull, British Indicators, St Albans, United Kindom) on the right side of the body, at the chest, abdomen, thigh, tricep, subscapular, suprailiac, and midaxillary sites. Body density was determined from the seven skinfold measures using the prediction equation validated by Jackson and Pollock (9). Percentage body fat was estimated by using the equation of Brozek et al., (10). Fat free mass (FFM) values were obtained from the measures of estimated body fat and body mass.

Arm–to-leg BIA: Body fat percentage was estimated using the BC-418 Segmental Body Composition Analyzer (Tanita, Tokyo, Japan). Subjects were measured for BIA while wearing only shorts. FFM and body density were calculated using the prediction equations supplied by the manufacturer. Subjects were asked to refrain from alcohol and vigorous exercise for 24 h prior to minimize perturbation of body fluid.

Measurements were scheduled at the same time of the day (8:00-10:00) with the athletes presenting in a fasted state. All measurements were executed by the same experienced physician specialized in sports medicine.

Statistical analysis

All the experimental data were analyzed using SPSS version 13.0 Statistical Software (SPSS Inc., an IBM Company, Chicago, IL, USA). Results were represented as mean and SD. A confidence level of 5% ($p < 0.05$) was considered significant. Correlations between the skinfold method and BIA method were determined by Pearson correlation coefficient. Dependent t-test was used to compare %BF values obtained using skinfold caliper and arm-to-leg BIA. In addition the difference in percent fat determined by the skinfold and BIA method was plotted against the average percent fat obtained from the two body composition techniques. This Bland-Altman (11) distribution is presented in Figure 1.

RESULTS

Percent body fat values differed between techniques ($p < 0.001$). The BIA method was found to demonstrated higher calculated body fat values compared to skin fold measurements. The difference between the two techniques showed a difference of 27.8 %. The mean values of the %BF are presented in Figure 2.

Significant correlations ($p < 0.01$) with $r = 0.56$ were found after the correlation analysis of percent fat obtained using BIA and skinfold method. The standard deviation of estimate ranged from 1.59 to 2.76 %.

In Figure 1 the difference in percent fat obtained via skinfold and arm- to- leg BIA is plotted versus the average percent by the two methods. The solid line represents the mean difference between the two techniques and the dashed lines correspond to one standard deviation. This Altman-Bland (11) plot indicates a systematic difference between the percent fat measured using arm-to- leg BIA and skinfolds.

Figure 1. Difference in %BF between methods plotted against the average percentage of body fat of the two methods. The solid line represents the mean difference between the two methods and the dashed lines correspond to one standard deviation.

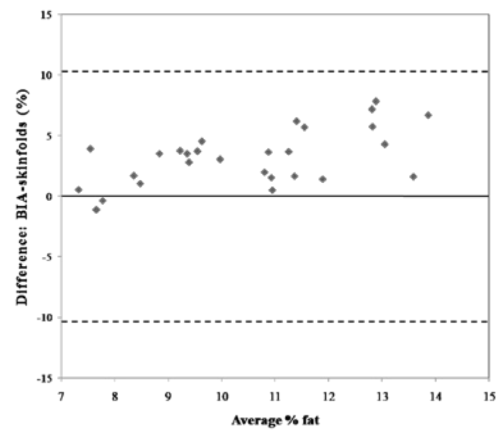
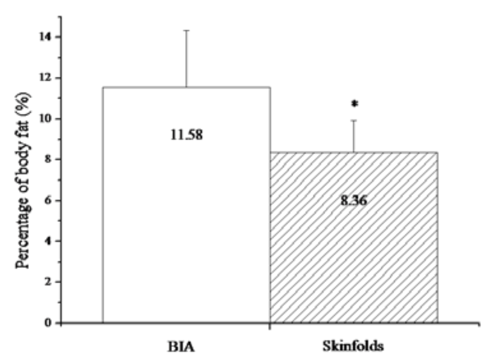


Figure 2. Percentage of body fat estimated with the use of BIA and skinfolds. Values are means ± standard deviation (SD).



* Indicates significant differences between the percentage of body fat estimated with the use of BIA and with skinfolds.

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DISCUSSION

In this study we use two methods that make indirect estimations of the percentage of body fat. The BIA is one of the most used methods for fast measurements. Also required less training for the examiners to perform this method and is more pleasant for the patients (less touches by the examiner). The BIA appears a lower intra- and inter-observer variability (12). However, it is necessary for trainers and patients to understand the limitations and to follow the instructions of the method (13).

In the second method we use skinfolds to estimate the percentage of body fat. This method shows a high consistency and correlation with the most accurate techniques such as DEXA (14) and densitometry (15). This fact in combination with the low cost of the equipment appoints this method as one of the most used (16). The skinfold technique has error introduced by inter- and intra-measurement variability so the examiners have to be educated in this technique.

Results from this investigation demonstrated that the arm-to-leg BIA system does not accurately assess percent body fat when compared to skinfold thickness measurement method within professional soccer players. This finding is in accordance with previous research (17) that has shown that leg-to-leg BIA in estimating percent body fat is not as accurate as that of skinfolds. However, in the study by Lukaski et al., (17) only intercollegiate athletes participated opposed to professional soccer players. However, in the literature a number of studies mentioned that the results of arm-to-leg BIA are similar to that of skinfolds (4,7,18).

In the present study the use of BIA overestimates the percentage of body fat in comparison with skinfold method. BIA measurements depended by the patients characteristics (19). Using BIA to estimate person's body fat assumes that the body is within normal hydration ranges. If a player is dehydrated the amount of fat tissue can be overestimated. Hydration can be affected by intense exercise or hot environment without replacing the fluids, drinking to much caffeine or alcohol.

Liang and Norris (20) reported that 1 kg acute loss in body weight following exercise had no effect on the BIA determination of percent body fat. While Lukaski et al., (17) on the other hand, reported a significant alteration in BIA determined percent fat consequent to exercise. Utter et al., (21) noted that the leg-to-leg BIA system accurately estimated percent body fat when compared to skinfolds. This study was performed with intercollegiate wrestlers. Cable et al., (22) compared leg-to-leg BIA, with underwater weighting and skinfolds method in estimating the percentage of body fat. They found that BIA is an effective method for estimating FFM in a group of adult males. Also a strong correlation coefficient between leg-to-leg BIA and DEXA was mentioned by Nunez et al. (3).

To our knowledge results of the present study are the first to compare the arm-to-leg BIA system with skinfolds in assessing the percentage of body fat within professional soccer players. The study demonstrated that the arm-to-leg BIA system does not accurately assess the percent body fat when compared to skinfolds in this population (professional soccer players). In the future, researches could study the validation of the two methods (arm-to-leg BIA and skinfolds) against a reference method like DEXA. In this way we are going to learn which method is more accurate to estimate the percentage of body fat in soccer professionals. However, DEXA and hydrodensitometry are two of the most valid methods to measure the percentage of body fat, but also require expensive equipment and specialized staff.

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