Body composition in dancers: the bioelectrical impedance method

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ABSTRACT

YANNAKOULIA, M., A. KERAMOPOULOS, N. TSAKALAKOS, and A.-L. MATALAS. Body composition in dancers: the bioelectrical impedance method. Med. Sci. Sports Exerc., Vol. 32, No. 1, pp. 228–234, 2000. Purpose: The aim of this study was to generate and validate a prediction equation for estimating the body composition in dancers using the bioelectrical impedance analysis (BIA) as a method of assessment. Methods: The fat-free mass (FFM) of 42 young female professional dance students was estimated by four different methods: dual x-ray absorptiometry (DXA), BIA, simple anthropometry, and skinfold thickness; DXA was used as a criterion method. Results: The dancers’ FFM was 42.6 kg (SD: 3.3) and, on the average, body fat represented the 19.4% (SD: 4.3) of their body weight. Two dancer-specific BIA equations for the prediction of FFM (E_BIA) were developed by multiple regression analysis using weight, height, resistance index, and triceps as predictor variables (E_BIA and E_BIA-TRICEPS). The validity of these equations as well as of those previously reported was assessed in two randomly selected subgroups of the initial study group, as described by the Bland-Altman analysis. The bias and the limits of agreement of the equations developed in the present study were lower than those resulting from the application of the previously used equations of Segal et al. and Hergenroeder et al. It was also found that, when validated against DXA, skinfolds measurements did not accurately predict body fatness in this group of young females. Conclusion: The new equations allow for an accurate routine assessment of body composition in young female dancers by using the method of BIA. Further studies are needed for the cross-validation of the equations in various groups of dancers. Key Words: NUTRITIONAL ASSESSMENT, EXERCISE, DUAL X-RAY ABSORPTIOmetry (DXA), ANTHROPOMETRY, PREDICTION EQUATIONS

The body physique assessment has received a great deal of interest in the area of sports science during the last two decades. The study of the body size, structure, and composition may be useful in evaluating the individual’s fitness for sport participation, characterizing the profile of athletes in different sports and determining the optimal body for both optimal performance and optimal health (31,36). Dance is a type of exercise, even though the artistic and esthetic component supersedes the athletic aspects of the activity (25). For dancers, being a particular group of athletes, the optimal body composition serves as the means for achieving both the physiological needs of a healthy body and the esthetic goal of thinness to obtain maximum on-stage performance.

Previous studies investigated the body composition of female dancers aiming either to provide descriptive characteristics of dancers or to determine the optimal body composition which would maintain the best standards of health and improve training techniques (1,4,5,7,14–19,21,25,34,37). The above studies indicated that even though dancers constitute a very lean group of athletes, their mean levels of fatness ranged widely, from 13.8 to 22.1% of body weight, depending on the study. The majority of the studies were carried out on elite dancers and mainly ballet dancers, and the most common methods used for the assessment of the body composition were the underwater weighing and the skinfolds measurements. Only recently more sophisticated methods, such as the dual x-ray absorptiometry (DXA), were introduced in the physical assessment of dancers (34).

DXA is a novel technique, which replaced dual-photon absorptiometry, and provides precise measurements of bone and soft tissue composition with a low radiation exposure (20,24).

The bioelectrical impedance analysis (BIA) has been used extensively in assessing the total body water and fat-free mass (FFM) of various groups of people, having many advantages over other methods: it is safe, rapid, portable, easy to perform, and requires minimal operator training (22,32). Its main limitation is that its accuracy is highly dependent on the selection of appropriate prediction equations, which should be as specific as possible to the study group in terms of age, sex, ethnicity, level of fatness, and health status (2). Although some of the published equations for lean or normal-weight females (29) could be applied to...
dancers, a prediction equation specific for them remains to be developed. Additionally, apart from one study that applied the BIA to a group of dancers for estimating their body composition (7), there is lack of research on the validity of the method in predicting fat-free mass (FFM) and percent body fat (%BF) in dancers.

The aim of this study was primarily to generate and validate a prediction equation for estimating the body composition in dancers using the BIA as a method of assessment. Second, previously used prediction equations of body composition were compared with the DXA method in a group of Greek dancers to assess their applicability in this lean and well-trained young female population.

METHODS

Subjects

Forty-two young female dancers were studied from a professional elite Dance School in Athens, Greece. After being informed about the purpose of the study, all subjects signed a written consent form. The study protocol was approved by the Ethics Committee of Harokopio University. During recruitment the dancers were asked to fill out a simple questionnaire on their general health status and daily exercise habits.

Anthropometry

Weight and height were measured using a spring scale and a wall-mounted stadiometer to the nearest 0.5 kg and 0.5 cm, respectively. BMI was calculated as weight(kg)/height²(m²). Waist, hip, and arm circumferences and arm length were measured to a precision of 0.1 cm using a plastic tape measure. Triceps, biceps, subscapular, and suprailiac skinfolds measurements were performed on the right side of the body, as described by Durnin and Womersley (13), to a precision of 0.2 mm, using a Lange skinfold caliper (Cambridge Scientific Instruments, Cambridge, MA). All measurements were done by a single, well-trained researcher from the research team.

Bioelectrical Impedance Analysis (BIA)

Resistance (R) and reactance (Xc) were measured with a single frequency (50 kHz), four-terminal impedance plethysmograph (Model 101, RJL-Systems, Mt. Clemens, MI) as described by Lukaski et al. (23), with the subject lying in a supine position, after an overnight fast.

Dual Energy x-ray Absorptiometry (DXA)

Bone mineral density (BMD), bone mineral content (BMC), and soft tissue composition of the total body as well of body parts (arms, legs, trunk) were determined with a DXA total body scanner (Model DPX+, Lunar Corp., Madison, WI), and calculated by the Lunar software 1.3z. The pixel size was 4.8 x 9.6 mm and a fast scan mode was used, with a scanning time of approximately 10 min. The fast speed mode was preferred for convenience reasons, since no significant differences have been found in the mean results or in the precision errors between the medium and the fast speed (24). The scanner was calibrated on a daily basis.

Body Composition Assessment

The dancers’ FFM was estimated by four different methods: 

- **DXA.** Lean bone-free tissue mass was measured by DXA. The FFM was estimated by adding these values and those of the BMC either for whole body or for individual parts of the body (arms, legs, and trunk).

- **Simple anthropometry.** FFM was estimated by weight alone using the following regression equation that was developed by Hergenroeder et al. (17) in female ballet dancers:

  \[
  
  \text{FFM (kg)} = 0.0064602 \times H^2 - 0.01397 \times R + 0.42087 \times W + 10.43485
  
  \]

- **BIA: Equations of Segal et al. (29).** FFM was estimated by BIA and anthropometric variables using the below fatness-specific equation developed by Segal et al. (29) for lean people (BF<30%):

  \[
  
  \text{FFM (kg)} = 0.73 \times W + 3 \times (R^2 = 0.88, \text{SEE} = 1.5 \text{kg})
  
  \]

- **BIA: New equations.** FFM was estimated by the two regression equations developed in the present study, the \( E_{\text{BIA}} \) and the \( E_{\text{BIA-TRICEPS}} \), as described below.

  The %BF was estimated from total body density, as it was calculated by the logarithmic transformation of the sum of skinfolds thickness at four sites, namely triceps, biceps, subscapular, and suprailiac (13).

  DXA was used as criterion method for the evaluation of all the aforementioned body composition methods and equations as well as for the development of the new equations for the FFM prediction.

Statistical Analysis

The descriptive characteristics of the group variables were expressed as mean values, SD, and ranges. Stepwise multiple regression analysis was performed to identify the best predictors of FFM from selected BIA and anthropometric variables (when each predictor variable was selected, the significance of its contribution to the \( R^2 \) of the equation was evaluated, \( P_{\text{entry}} < 0.05 \)). The Bland and Altman analysis (3) was used to assess the relative validity of the developed regression equations in two randomly selected subgroups of the initial study group. The same procedure was also followed for assessing the validity of the other body composition methods against the DXA. In summary, in the Bland and Altman analysis, the values derived from two methods of clinical measurement are compared by plotting their difference against their mean or average. The bias (mean difference) and the limits of agreement (± 2 SD) were calculated in each case, as well as the correlation coefficients for evaluating the relation between difference and means. The level of significance was defined at \( P < 0.05 \).
TABLE 1. Age and anthropometric and other descriptive characteristics of young female dancers (N = 42).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>21</td>
<td>2</td>
<td>18–26</td>
</tr>
<tr>
<td>Age starting dance (yr)</td>
<td>6.0</td>
<td>3.1</td>
<td>3.0–14.0</td>
</tr>
<tr>
<td>Hours of dancing per week</td>
<td>28.3</td>
<td>6.3</td>
<td>18.0–48.0</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>162.6</td>
<td>4.9</td>
<td>151.0–171.0</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>52.6</td>
<td>4.3</td>
<td>45.0–63.5</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>19.9</td>
<td>1.2</td>
<td>17.1–22.5</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>64.5</td>
<td>3.6</td>
<td>58.5–72.5</td>
</tr>
<tr>
<td>Hip circumference (cm)</td>
<td>91.3</td>
<td>3.9</td>
<td>83.0–102.0</td>
</tr>
<tr>
<td>Skinfolds (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triceps</td>
<td>12.5</td>
<td>3.6</td>
<td>5.5–21.0</td>
</tr>
<tr>
<td>Biceps</td>
<td>4.7</td>
<td>1.6</td>
<td>2.0–9.0</td>
</tr>
<tr>
<td>Subscapular</td>
<td>8.7</td>
<td>2.3</td>
<td>5.0–16.0</td>
</tr>
<tr>
<td>Suprailiac</td>
<td>9.1</td>
<td>2.9</td>
<td>4.5–16.0</td>
</tr>
<tr>
<td>Resistance (Ω)</td>
<td>525</td>
<td>69</td>
<td>345–664</td>
</tr>
<tr>
<td>Impedance (Ω)</td>
<td>572</td>
<td>70</td>
<td>325–668</td>
</tr>
<tr>
<td>BMD (g/cm²)</td>
<td>1.180</td>
<td>0.068</td>
<td>1.024–1.298</td>
</tr>
<tr>
<td>TBMC (g)</td>
<td>2561</td>
<td>287</td>
<td>2078–3178</td>
</tr>
<tr>
<td>FFM (kg)</td>
<td>42.55</td>
<td>3.30</td>
<td>35.61–50.08</td>
</tr>
<tr>
<td>BF (%)</td>
<td>21.3</td>
<td>3.2</td>
<td>13.0–26.9</td>
</tr>
<tr>
<td>BF (%)*</td>
<td></td>
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</table>

*As determined by DXA.

RESULTS

The mean age of the 42 dancers was 21 yr (SD: 2, range: 18–26). On average, they started dancing at the age of 6.5 yr and they typically danced 29 h wk⁻¹ or approximately 5 h d⁻¹ for 6 d wk⁻¹ (as a part of their daily training or their supplementary on-stage performance). Their anthropometric and body composition characteristics as well as the BMD and soft tissue composition, assessed by DXA, are shown in Table 1. The mean BMD was 1.180 g cm⁻² (SD: 0.068, range: 1.024–1.298), the FFM, as determined by DXA, was 42.6 kg (SD: 3.3, range: 35.6–50.1) and, on the average, BF represented the 19.4% (SD: 4.3, range: 10.3–30.4) of their body weight.

To determine the relative importance of anthropometric and BIA variables in predicting FFM, single and multiple regression analyses were conducted for weight and height separately and consequently with the inclusion of the resistance index ($H^2/R$) (Table 2). Correlation coefficients (R) and coefficients of determination ($R^2$) for resistance index plus weight and height were higher than those obtained from any other variables or set of variables, and similarly the SEE were lower.

Stepwise multiple regression analysis was performed to develop equations for the prediction of the FFM. The development of the new regression equation was attempted at a first stage by using the independent variables of age, weight, height, and impedance measures, namely resistance, reactance, resistance index ($H^2/R$), and impedance, and second, by adding to the analysis the four individual skinfolds and the sum of them. The results are shown in Tables 3 and 4, respectively. The best equation for predicting FFM from BIA and simple anthropometric variables was the following:

$$\text{FFM (kg)} = 0.247 \times W + 0.214 \times (H^2/R) + 0.191 \times H - 14.96$$

($R^2 = 0.83, \text{SEE} = 1.45$). This equation will be referred to as $E_{\text{BIA}}$ (Table 3). When it was attempted to enter the four skinfold values, namely triceps, biceps, suprailiac, and subscapular, and the sum of these skinfolds in the stepwise multiple regression analysis (Table 4), only the variable of triceps improved slightly the FFM predictive equation. The improved equation, referred to as $E_{\text{BIA,TRICEPS}}$, is as follows:

$$\text{FFM (kg)} = 0.391 \times W + 0.168 \times H - 0.253 \times \text{Triceps} + 0.144 \times (H^2/R) - 9.49$$

($R^2 = 0.87, \text{SEE} = 1.32$).

The validity of the two equations derived from this study was assessed in two randomly selected equal subgroups of the initial study group ($n_1 = n_2 = 21$), by using the Bland-Altman analysis, and the results are shown in Table 5. The biases of FFM predicted by both regression equations in the two subgroups were not statistically different than zero, and they do not differ significantly between them. The limits of agreement were of acceptable validity for both prediction equations, bearing in mind that the mean FFM measured by DXA was 42.55 kg.

The validity of predicting FFM by selected equations previously reported was also examined. The equations of Segal et al. (29) and the Hergenroeder et al. (17) were tested in this group of dancers, and the results are shown in Figures 1 and 2, respectively. Both equations showed clinically acceptable agreement with the reference method. The bias and the limits of agreement were higher for the Hergenroeder regression equation, using body weight alone, than for the BIA equation developed by Segal et al. (1.20 ± 4.36 kg FFM vs 0.25 ± 3.10 kg FFM). Additionally, the bias for the Hergenroeder equation was statistically different than zero ($P < 0.0001$), whereas for the Segal equation the means of FFM estimated by the equation and those measured by DXA were not significantly different. No statistically significant correlation was detected between average and difference as shown in Figures 1 and 2.

The %BF predicted from the skinfold equation was also validated against the DXA method in this group of dancers. The average values of %BF, as measured by DXA and estimated by skinfolds, were plotted against their difference (Fig. 3), and the correlation coefficient was 0.31 ($P < 0.05$). The relationship between differences and %BF values was influenced by the %BF, a finding that implies that the bias by using the skinfolds for estimating %BF is dependent on the degree of fatness in this group of dancers.

DISCUSSION

The present study is the first in Greece, and among the few in Europe, which investigated body composition of dancers. The results indicate that the Greek female dancers studied constitute a group of lean women with a mean body...
TABLE 4. Prediction of FFM from body weight, height, BIA variables, and skinfolds by stepwise multiple regression analysis (equation E BIA-TRICEPS) in young female dancers.*

<table>
<thead>
<tr>
<th>Steps</th>
<th>Weight (kg)</th>
<th>H2R−1 (cm²·Ω−1)</th>
<th>Triceps (mm)</th>
<th>Height (cm)</th>
<th>Intercept (kg)</th>
<th>R</th>
<th>R²</th>
<th>SEE (kg)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.608</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>10.72</td>
<td>0.79</td>
<td>0.62</td>
<td>2.11</td>
<td>0.0001</td>
</tr>
<tr>
<td>2</td>
<td>0.411</td>
<td>0.196</td>
<td>—</td>
<td>—</td>
<td>10.98</td>
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* The variables of age, resistance, reactance and impedance did not enter the model at P_{entry} level <0.05.

Fat of 19.4%. This value falls within the range of 17–23% BF which was proposed by Chmelar and Fitt (6) as an optimum body composition for University adult female dancers. These guidelines were based on several studies using various methods of body composition in university adult female dancers. However, the levels of fatness measured in the present study are in the middle to the upper range of the %BF values reported for dancers elsewhere (1,5,7,11,18,25,34), but one should bear in mind that these subjects were students in professional dance schools, being engaged in both ballet and modern dance activities. Professional dancers have characteristics that clearly differentiate them from dance students. If leanness is deemed necessary by dance teachers and staff of the dance schools, its importance is exaggerated by dance companies, especially those focused on the ballet dance. Dance teachers put much less pressure for an ultra-lean body on their students than choreographers and dance companies on their professional dancers. In addition, professionals have already undergone the selection process, and they may have been chosen among other students for their lean athletic form. On the other hand, modern dance entails a broader range of body types and approaches to techniques than classical ballet, allowing the dancers for a slightly higher body weight than the reference “Sylphide” silhouette (8).

In relation to the use of BIA in predicting FFM in dancers, the results of the present study indicate that the resistance index, as a BIA variable, contributes significantly to the prediction of FFM. When used as a single variable, the resistance index is a good predictor of FFM, and when combined with the anthropometric variables of weight and height explains more than 80% of the variance of the FFM. These variables, weight, height, and resistance index, have also been used in previous studies for the prediction of FFM (9,10,28). However, as it has been argued by Diaz et al. (10), the anthropometric variables are highly interrelated, and therefore when height, weight, and other variables are included in stepwise model, the existing collinearity between those variables may artificially enhance the association between BIA variable and FFM or other components of body composition. In this study, the inclusion of the resistance index in a FFM predictive equation containing only weight and height is justified by the fact that the BIA variable substantially increased the R² of the prediction (from 0.66 to 0.81).

The regression analysis resulted in two predictive equations for estimating the FFM of female young dancers. The size of the group studied can be considered as being adequate for the development of BIA equations, since these young female dancers constitute a specific group of subjects with very discrete characteristics. The E_BIA that estimates the FFM from the weight, height, and resistance was slightly improved in E_BIA-TRICEPS when the values of triceps were included in the model. Nevertheless, the error of the observer in measuring accurately triceps (measuring site, the way skinfold was picked up, the depth of the caliper hold) is far more important than the resulting reduction of 0.13 kg in the SEE in the E_BIA-TRICEPS. The more restricted model of E_BIA may sacrifice a small amount of prediction strength, but it substantially simplifies the prediction. The validation of the two equations in the two randomly selected subgroups of the initial study group revealed that both can accurately predict FFM in dancers. The bias and the limits of agreement when applied to any of the subgroups were lower than those resulting from the application of the published equations of Segal or those of Hergenroeder. In conclusion, both equations can be properly used, but the application of the E_BIA for the prediction of FFM in female dancers of similar age and physical and training characteristics is preferable because of its advantage of being a simple method for a routine assessment, with lower observer and/or measurement error.

One concern in relation to the validation of the above equations is the use of the same dancers for the development of the prediction model and its validation, since cross-validation ideally refers to the application of a predictive equation to a sample independent from the one used to build the equation (by using the same instruments and procedures). This approach, however, is usually expensive and sometimes intractable. For this reason, many researchers follow the data-splitting approach, in which a subgroup of the initial sample is used to develop the equation and the group consisting from the remaining subjects is used for cross-validation (16). The approach used in this paper, i.e.,

TABLE 3. Prediction of FFM from body weight, height, and BIA variables by stepwise multiple regression analysis (equation E_BIA) in young female dancers.*

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developing the equation in the whole group of subjects and then validating the equation in two subgroups of the initial study group, has its limitations, but it was imposed by the limited number of subjects. The number of subjects was appropriate for the development of the equation but not for the application of the data-splitting approach. However, considering that the two subgroups were randomly selected, this validation approach indicates that the two new equations were valid in the studied group and not biased by the outliers. Further validation in independent group of dancers having the same characteristics with those measured in this study will strengthen the power of the equation developed.

The fatness-specific equation of Segal et al. (29) for estimating FFM in lean and normal weight (BMI, 23 kg/m²) female subjects from resistance and simple anthropometric variables has also been cross-validated in this group of female dancers and showed very good agreement with the reference values. The absence of any significant correlation in Figure 1 denotes that the differences in FFM values calculated by the Segal equation and those measured by the DXA did not vary over the range of values. The subjects of the present study had the same physical characteristics (except for age which was lower in our group) with the original “Segal equation” study group. This fact confirms the generally purported position that the accuracy of the BIA depends highly on the careful selection and use of appropriate predictive equations, developed from a sample with similar characteristics (age, sex and racial, health and fatness status) with the group to be studied (2).

Hergenroeder et al. (17) developed a simple regression equation for specifically estimating the FFM in female ballet dancers using body weight as the only predictor variable. The absence of any correlation in Figure 2 points out that the differences in FFM values obtained by the Hergenroeder equation and the DXA were not influenced by the magnitude of the FFM. However, the FFM was in most dancers in this study underestimated, and the limits of agreement with the DXA values were the greatest among all the equations and the methods examined. Two reasons may account for the discrepancy between the two methods. Firstly, this particular equation can accurately estimate FFM, as mentioned by the authors, in accomplished ballet dancers, who resemble, in terms of years of dancing and weekly training hours,

![Figure 1](image1.png)


![Figure 2](image2.png)


![Figure 3](image3.png)

the sample of dancers from which the equation was developed. The dancers in the present study, however, were dance students, not exclusively engaged in ballet dance, and with more dancing hours per week than the group of Hergenrøder et al. (17). Additionally, for the development of the equation, the Total Body Electrical Conductivity (TOBEC) was used for providing reference values. TOBEC constitutes a method of body composition assessment that is marginally more accurate than BIA but also subject to many of the same limiting assumptions that apply to BIA, such as homogenous cylindrical conductor, uniform conductivity, constant cross-sectional area, and known length (2). Consequently, its use as a criterion method may have important limitations and could limit the validity of the developed equation.

The measurement of skinfolds has also been used in previous studies for the body composition assessment of ballet dancers (1,7,11,25). The percentage of body fat was estimated either by the widely used Durnin and Womersley equation (13) or by the Sinning equation (30) specifically developed for young gymnasts. Our results on %BF, as estimated by the sum of skinfolds and the equation of Durnin and Womersley, were very close to those found in a previous study using the same skinfold equation (1). However, among all methods compared in the present study, the measurement of skinfolds was found to be the least accurate. The correlation coefficient of 0.31 in the Bland-Altman analysis denotes that the agreement between the values obtained by DXA and skinfolds varied among high and low values of measurement. The discrepancy between these two methods is influenced by the %BF: skinfolds seem to overestimate the %BF in very lean dancers, but this trend is attenuated in higher levels of body fatness. This finding excludes the possibility of the presence of a systematic measurement error and points to a prediction error. For most purposes, skinfold measurement is considered to be a direct method for estimating the degree of body fatness not only adequately, but also easily, quickly, and inexpensively (12). The equation of Durnin and Womersley (13) has been derived from a sample of people with varying degrees of body fatness and fitness, including a number of dancers from a ballet company. Despite being repeatedly cross-validated in samples of varied origin, it cannot be accepted as a general equation (26). Indeed, in this particular group of young lean females, it does not predict accurately body fatness, at least when validated against DXA. Although it has been reported that estimates of body composition using skinfold measurements are relatively imprecise (18), to the best of our knowledge, this is the first study that assessed the validity of skinfolds in estimating %BF in dancers. The issue needs further investigation; maybe another more dancer-specific equation, using other sites of measurements, could better predict the body composition in dancers.

The regression equations in the present study were developed against the reference values of FFM measured by the DXA. Although DXA is often cited as one of the reference standards for the body composition studies, some reservations have been pointed out on the application and the limitations of the technique (27). Comparisons of DXA with underwater weighing and a two-compartment model, a method that has been used so far as the classical criterion method, showed good agreement both in groups of healthy people with normal hydration and in ballet dancers (34,35).

In women in particular, DXA gives comparable results to underwater weighing, provided that FFM is defined as the sum of lean tissue measured by DXA and the BMC (33). On the other hand, when DXA was compared with the four-compartment model, it was found, as expected, less accurate in estimating body fat and fat-free mass in healthy adults and in dancers (15,34), but it has been recognized as the best predictor of mean body composition obtained from four separate two-compartment reference methods (underwater weighing, deuterium dilution, DXA, and total-body potassium). The reservations that some researchers have in respect to the applicability of DXA in the measurement of soft tissue composition and its use as a “gold standard” refer to the lower validity of the method in specific study groups, such as infants or people with altered hydration status, or in regional measurements instead of whole body measurements of soft tissue (20,27). It is our belief that DXA can be safely used as a criterion method for the estimation of the whole body FFM in this group of healthy female young dancers, offering the advantage of uniquely measuring both bone and soft tissue composition.

In conclusion, the dancers in the present study constitute a lean population group with a mean %BF of 19.4, as estimated by the DXA. It was found that the BIA can accurately be used for the estimation of the body composition of young female dancers; the regression equation derived was the following: FFM (kg) = 0.247·W + 0.214·(H²/R) + 0.191·H − 14.96 (R² = 0.83, SEE = 1.45). This is the first dancer-specific equation for the estimation of body composition with the use of BIA. Further studies are needed for the cross-validation of the equation in various groups of dancers.

The authors are grateful to Ms. D. Efthimiou-Tsekoura, director of the State School of Dance, Athens, Greece, who facilitated this research at all stages; the IASO S.A. Obstetrics and Gynaecology Hospital, Diagnostic, Therapeutic and Research Center, Athens, Greece, for financially supporting the DXA measurements; Ms. Stella Tzagaki who carried out the DXA measurements; Dr. Paul Deurenberg, who provided constructive comments and professional guidance; the Hellenic Ministry of Culture and the Harokopio University for supporting the project. Finally, the authors would like to express their gratitude to all dancers who enthusiastically participated in this project.

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