Predictive Accuracy of Bioimpedance Method for Assessing Body Composition of Brazilian Menopause Women

ABSTRACT: The purpose of this study was to determine the predictive accuracy of the Bioimpedance (BIA) method for the assessment of the body composition of 95 Brazilian post-menopause women (62.27 ± 7.69 years). The BIA method is relatively not expensive, fast and not invasive (LUKASKI, 1987). However, the validity of this method has never been tested in older Brazilian women. Moreover, CHUMLEA & BAUMGARTNER (1989) do not recommend the use of the hydrostatic weighing in older individuals. Thus, the DXA (DPX-IQ, Version 4.6) was used to obtain the reference relative fat (%BF), and the fat-free mass (FFM). The total body resistance was measured with a BIA RJL model. The LOHMAN (1992) specific equation for elders, and the SEGAL et al. (1988) fatness specific equations (obese > 30%BF and not obese < 30%BF) were analysed in this study. The results were as follows: The LOHMAN et al. (1992) BIA equation presented a good validity coefficient (r = 0.88), an excellent standard error of estimation (SEE = 2.01 kg). However, the LOHMAN equation significantly overestimated the FFM of the studied sample (D = - 0.63 kg). However, the BIA equations of SEGAL et al. (1988) accurately estimated the FFM of the studied sample (D = 0.40 kg), and presented an acceptable error (SEE = 2.11 kg). Based on these results, it can be recommended to physical education professionals, endocrinologists and nutritionists the use of the BIA method for the assessment of the body composition of Brazilian menopause women.

Keywords: Body composition, Bioimpedance, Menopause, DXA
INTRODUCTION

Naturally, always that is mentioned on corporeal composition think that is reserved exclusively for athletes, so is the performance from the athlete is partially influenced by the proportion of corporeal fat (CG) and the thin corporeal mass (MCM) (BOTTAURO et al., 2002). With all, the corporeal composition is an important aspect on the health from the individuals, independently of the age, sex, and ethnical source. According with the American College of Exercise Medicine (2000), the obesity is linked to an enlargement on the risk of developing cardio vascular disease, hypertension, diabetes, certain types of cancer and many other chronic diseases.

The classic model from two components from the SIRI (1961) and BROZEK et al., (1963), which separate the total corporeal mass (MCT) in corporeal fat (CG) and in thin corporeal mass (MCM), is being used on obtaining the measures of references from the corporeal composition. The model from two components is based on the following suppositions: a) the fat density is at 0.901 g/cc; b) the MCM density is at 1.10 g/cc and c) the MCM contains 73.8% of water, 19.4% of protein and 6.8% of mineral (BOTTAURO, 2000). It is known that the water proportion, proteins, and mineral on the MCM and consequently, the thin corporeal mass density (dMCM) varies according with the age, sex, ethnic, levels of corporeal fat, and levels of physical activities (BAUMGARTNER et al., 1991; WANG et al., 1989; WILLIAMS et al., 1993).

The modifications on the proportion of the density and the thin corporeal mass component (MCM), due to getting older, it limits the utility of the model into two components to estimate the corporeal fat related to the elderly individuals. With the elderly, the mineral related contained on the thin corporeal mass (MCM) decreases approximately of 1% per year, after the 50 and 70 years old (ADAMS et al., 1970; SMITH et al., 1976). Due to this modification, the dMCM on elderly ones, particularly on elderly women, is less than the value assumed of (1.10 g/cc) for the model of the both components. So, equations of prediction based on the model from two components of SIRI (1961) and BROZEK et al. (1963) tend systematically to superstimate the related fat corporeal (%GC) on the elderly population of 2% to 4% (BAUMGARTNER et al., 1991). For this reason, on the development of the equation of prediction for elderly ones, the multi components models of corporeal compositions are more indicated than the two component ones.

The Bioimpedance method (BIA) is becoming very used on the estimation of the corporeal composition to be one of the cheapest methods, quick and non invasive (LUKASKI, 1988). So, the expiration of this method was never tested on elderly Brazilian women. So, the present study has as an aim to estimate the precision and applicability of the equations of BIA on the estimation of the corporeal compositions in menopause Brazilian women, using Astrometry Radiological of Double Energy (DXA) as a reference method.
MATERIALS AND METHODS

Sample

It makes part of this study one sample of 95 women, on the menopause (62.27 ± 7.699 years old) apparently healthy. On the same study, all the participants live in Taguatinga, DF, and they have participated from the study in a voluntarily way. All were informed of the aim of the study, from the proceedings, from the possible uncomfortable situations, risks, and benefits of the study before they have signed the term of approval. The participants wouldn’t add on the study if they show any disease which would compromise the corporeal composition as: certain types of cancer, diseases of the liver and/or renal, and muscular dystrophy.

PROCEEDINGS

Impendence Bio electric (BIA)

The total corporeal resistance (Ω) and the reaction (Xc) were measured according with the standard proceedings, following the manufacturer’s recommendations, by the means of an analyzer tetra polar of impendence bio electric (RJL Quantum X, Systems, Inc, Detroit). The measuring ones were accomplished on the right side of the body after the participants were kept on the supine position for 10 – 15 minutes (LUKASKI et al., 1988; KUSHNER & SCHOELLER, 1986). The BIA equations used, estimated on the present study, are displayed on the Chart 1.

Absortometry Radiological from the Double Energy (DXA)

The DXA is a technology relatively new which comes to be recognized as a method of reference for the research on the corporeal composition. It is also a good alternative for the hydro densitometry as a method of reference to be safer, quicker (the total corporeal composition takes from 10 to 20 minutes), requires a coop minimum from the individual and, the most important, by considering the individual variability from the bone’s mineral. The MLG was measured by an equipment of DXA by the brand Lunar, module DPX-IQ (Software 4.6A). The tests were comprehended on a total sweeping from the body’s participant, who gives a complete estimation in terms of bone’s density, fat mass and thin mass.

Draw of the Research and Analyze Statistic

This study has shown one approach correlation to estimate the relation among the obtained measures with the reference method and the measures obtained by the equations of regression of BIA. The criteria of validation used to determine the precision from the methods of the field selected were the ones proposed by LOHMAN (1992) and resumed by HEYWARD and STOLACZYR (1996).

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Equation</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-70 years-old</td>
<td>MLG(kg)=0.474(EST²/R)+ 0.180(PC)+7.3</td>
<td>LOHMAN (1992)</td>
</tr>
<tr>
<td>17-62 years-old (&lt;30 % GC)</td>
<td>MLG(KG)=0.000666360(EST²) - 0.02117(R) + 0.62854(PC) - 0.12380(Id)+9.33285</td>
<td>SEGAL (1988)</td>
</tr>
<tr>
<td>17-62 years-old (≥30 % GC)</td>
<td>MLG(KG)=0.00088580(EST²)-0.02999(R) + 0.42688(PC) – 0.07002(Id) + 14.52435</td>
<td>SEGAL (1988)</td>
</tr>
</tbody>
</table>

Where: Id= Age; MLG= Fat Free Mass; EST= Stature (cm); R= Resistance; PC= Body Weight.

Table 1 - Evaluated BIA equations for women
These criteria ones includes: a) test of dependent t of Student to estimate the differences among the averages of scores obtained by the method of reference and the scores predicted by the methods of the field; b) calculating the coefficient of correlation ($r$); c) analyze the standard error of estimating (EPE) and the constant error (EC); d) calculating the coefficient of correlation among the amounts of the reference and the scores residual ones; e) comparison of the bending and the intersection on the straight line of regression with the straight line of identity; and f) analyze the scores residual individual from each method and equation by the method by BLAND and ALTAMAN (1986).

**RESULTS**

The described characteristics of the sample are showed on the Chart 2. As it can be seen, the average of age from the women studied was at 62.27 ± 7.69; the average of the stature was at 152.04 ± 5.80; the average of corporeal mass of 64.27 ± 9.99; and the average of % of fat by the method of reference DXA was at 26.62 ± 7.17.

The results of crossed validation on the equations from Bio impedance are displayed on the Chart 3.

Table 2 - Physical Characteristics of the Sample (N = 95).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Average ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>62.27 ± 7.69</td>
<td>48 a 82</td>
</tr>
<tr>
<td>Stature (cm)</td>
<td>152.04 ± 5.80</td>
<td>137.00 a 166.50</td>
</tr>
<tr>
<td>Body Mass (kg)</td>
<td>64.27 ± 9.99</td>
<td>40.80 a 97.20</td>
</tr>
<tr>
<td>$%_{\text{DXA}}$</td>
<td>26.62 ± 7.17</td>
<td>8.92 a 49.09</td>
</tr>
<tr>
<td>$MLG_{\text{DXA}}$ (kg)</td>
<td>37.64 ± 4.26</td>
<td>29.17 a 48.17</td>
</tr>
<tr>
<td>$MLG_{\text{Segal}}$ (kg)</td>
<td>38.27 ± 3.99</td>
<td>28.38 a 47.31</td>
</tr>
<tr>
<td>$MLG_{\text{Segal}}$ (kg)</td>
<td>37.24 ± 4.32</td>
<td>27.99 a 48.73</td>
</tr>
</tbody>
</table>

Table 3 - Results from the Precision of the BIA Equations (N = 95).

<table>
<thead>
<tr>
<th>Equation</th>
<th>Average MLG (kg)</th>
<th>$r$</th>
<th>EC (kg)</th>
<th>t</th>
<th>EPE (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DXA</td>
<td>37.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIALohman (1992)</td>
<td>38.27</td>
<td>0.88</td>
<td>-0.63</td>
<td>-3.04**</td>
<td>2.01</td>
</tr>
<tr>
<td>BIASEgal (1988)</td>
<td>37.24</td>
<td>0.87</td>
<td>0.40</td>
<td>1.77</td>
<td>2.11</td>
</tr>
</tbody>
</table>

Where: * $p<0.05$; ** $p<0.01$; EC = Constant Error; $R$ = Correlation Coefficient; EPE = Standard Estimative Error Error; $MLG$ Fat Free Mass

The relations among the method of reference DXA and the MLG predicted by the equations by BIA (LOIHMAN, 1992 and SEGAL et al., 1988) are displayed on the Pictures 1 and 2. The analyze from the scores residual ones proposed by BLAND & ALTAMAN ($MLG_{\text{DXA}} + MLG_{\text{BIA}} / 2$) are displayed on the Picture 3.

**DISCUSSÃO**

Based on the very little knowledge regarding the equations predicted which makes part of the softwares from the analyzers by BIA, and the biological variability existent on what is referred to the sex, age and levels of physical activity, SEGAL et al., (1988) have developed and validated these equations to an estimation of Fat Free Mass through the BIA method for a great sample of adults, as being 1069 men and 498 women, with ages among 17 and 62 years old and a corporeal fat among 3 to 56%. This study, there was resulted two equations of prediction for women: a) non obesity (>30% GC), with $r=0.91$ and EPE = 2.0 kg; and b) obesity ones (>320% GC), with $r=0.96$ and EPE = 2.0 kg. These equations were recently modified by STOLARCZYK et al., (1997), using (<25% GC) for non obesity ones and (>35% GC) for obesity ones.

The equations of prediction by BIA are based as on specific population modules as generalized ones. These equations estimate

Picture 4 – Analysis of the residual scores of Lohamn MLG and MLG average = ($MLG_{\text{DXA}} + MLG_{\text{Segal}} / 2$)
the MLG and the Total Corporeal Water (ACT) due to the relations established among these and the measure of impedance Bio electric. Most of the BIA equations on specific populations were developed for sub groups homogeneous, by considering the differences of age, ethnic, sex, level of physical activity and level of corporeal fat. So, these equations are valid and may just being applied for individuals whose physical characteristics are similar to those from the sub group specific.

As one alternative for the specific equations on populations, the generalized equations of BIA, developed for heterogeneous populations varying the age, sex and level of corporeal fat, may be used. This approach consider the biological variability among the sub groups population, including factors as age and sex as a variable of prediction in BIA equations for estimating the MLG or the ACT (DEURENBERG et al., 1990; GRAY et al., 1989; KUSHER & SCHOELLER, 1986; LUKASKI & BOLONCHUK, 1988; VAN LOAN & MAYCLIN, 1987). According with the observations done by LOHMAN (1992), the resource statistic of most importance on making the equations of regression are the EPEs. According to LOHMAN, the EPE verify how the values predicted (estimated by the equations of regression) are sub estimated or super estimated the real amounts (in this case, the MLG determine by BIA). As a limit of precision, the author approves that on the equations of estimation of MLG, the EPE may not go through 2.8 kg.

Another aspect analyzed on the validation of the equations of this study was to compare the measures obtained through the t test dependent among the MLG determined by the BIA and the MLG estimated by the method of reference of DXA. On this particular case, there was observed that the t test dependent has indicated that there aren’t any significant difference (p>0.05) among the averages, evidencing like that the usage of the equations of estimation of GC of BIA, by SEGAL et al., (1988) produces the amount of MLG extremely trustful.

According to STOLARCZYK et al., (1995), in an accomplished research with Spanish women, the equations by LOHMAN, GRAY and SEGAL estimated with validation the MLG of the model of two components into ± 1.0 kg. The errors of the prediction for these equations were similar to the present study, varying of 1.9 to 2.1 kg. Due to none of these three equations of BIA may be used to estimate the MLG on Spanish women, the result found have placed into the acceptable limits, the same occurs with the present research accomplished with Brazilian women post-menopause, where the standard error of estimate was at 2.01 kg for the equations by LOHMAN and at 2.11 kg for the equation by SEGAL, and the errors of predictions for these equations were also similar, varying of 2.01 and 2.11 kg, respectively. For the realized research with Spanish women was recommended the equation generalized by GRAY et al., (1989), by two reasons: a) the equations by SEGAL are specifically to the adiposity, so, in order to select the appropriated equation, it must be determined of 0% of GC from the individual is more or less than 30%; and b) the equations by LOHMAN are specifically to the age, so, it must be used two separated equations to estimate the MLG from women among 18 and 29 years old and 30 to 49 years old.

A few equations of BIA specifically for the ages are based on models multi components, which correct the variability, inter individual from the content bone mineral and /or total corporeal water. The equation by LOHMAN (1992) for elderly ones (from 50 to 70 years old) was developed using this module (multi components) estimating the MLG, adjusting for the bones mineral, with a grade acceptable of precision (EPE=3.0 kg on men and 2.8 kg on women). The validation crossed on the equations for elderly ones by LOHMAN (1992) in an additional sample on elderly women, varying among 50 and 70 years old, by JENKINS et al., (1994) and WILSON et al., (1992) resulted in a little difference which are not significant on the MLG (<0.8 kg). Now on the present study, due to a less significant difference on the MLG (0.6 kg), this was sub estimated in a significant way this significant may be due to the size of the sample from this study (n=95). The studies by JENKINS et al., (1994) and WILSON et al., (1992) also had a good validation of prediction (EPE=2.1 to 2.4 kg, respectively), results very similar to the ones found on Brazilian women from this present study (EPE=2.1 kg). So, due the little significant difference (EC=0.63 kg) of the MLG estimated by the equation by LOHMAN (1992), it may also be used to estimate the corporeal composition on Brazilian elderly women.

CONCLUSION

The method of BIA, when applied with the equations analyzed on this study, it may be recommended for using on Brazilian women, apparently healthy, and with physic characteristics similar from the sample studied (48 to 82 years old). So, with bases on these results, it may recommend to the professionals of Physical Education, Endocrinologists and Nutritionists the usage of the BIA method on estimation the corporeal composition on Brazilian women on menopause.

REFERENCES


