

## 68 - COMPARISON OF THE PERCENTAGE OF BODY FAT BETWEEN BIOELECTRICAL IMPEDANCE METHODS – TETRAPOLAR VS BIPOLAR

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### INTRODUCTION

The accurate estimative of body composition gives important information in physical exercise programs, weight control, maintenance of physiological function, therefore are related to individuals health and quality of life (MCARDLE; KATCH; KATCH, 2003).

The body composition assessment divides the weight in components where the sum is the total weight. Thus the assessment includes the measurement of fat mass, fat free mass, and total body water. Moreover, the free fat mass can be divided in lean body mass, including water and bone and are directly related with health and longevity (SUN & HEYMSFIELD, 2003).

Several methods for body composition assessment like hydrostatic weighting, pletismography, DXA become inaccessible due to the high cost of equipment. Simple methods as bioelectrical impedance (BIA) skinfold measurement remain the most utilized (SUN; FRENCH & MARTIN, 2005).

BIA is a rapid and non invasive method, don't requires great professional training when compared to other methods, shows good accuracy and is painless (SUN; FRENCH & MARTIN, 2005). Is based on passing an electric current of low amplitude (500 to 800 mA) and high frequency (50 Khz) to the body, and gives the follow components: resistance (R), reactance (Xc), impedance (Z) phase angle (°) (NEWTON et al 2006; BRACCO et al, 1996).

The methodology for using BIA must be judicious to avoid inaccurate measures (SUN; FRENCH & MARTIN, 2005). Regarding the estimating equations suggests that they are specific for age and ethnic group. Therefore, for accurate evaluation of body composition the researcher must be careful whether the equations provided in the analyzer apply to the measured subject characteristics (MCARDLE; KATCH; KATCH, 2003; SUN & HEYMSFIELD, 2003). Since there are different BIA analyzers, the objective of this study was to compare, in male and active young adults, whether there is significant difference in results provided by two BIA analyzers: footpad vs. tetrapolar.

### METHODS

The sample consisted of 18 healthy male volunteers, students of Physical Education, aged 21,7 yrs with BMI <25 and physically actives.

All experimental producers was approved by Positivo University human research ethics committee (008/2005).

Anthropometric data was collected using a stadiometer (SECA®, model 206) for height and a balance (WELMY®, model R-110) for weight. For BIA measures was used a tetrapolar analyzer (MALTRON, model BF-906) and footpad analyzer (PLENNA, model TIN-99).

During the tetrapolar BIA analyzes the subjects were lying on a stretcher in the supine position, with no shoes, socks, watches, bracelets or similar with hands and legs apart. The electrodes was positioned in the following anatomical points: two in the right foot (the distal at the base of the middle finger and the proximal in the ankle joint line) and two in the right hand (the distal at the base of the middle finger and the proximal in the wrist joint line). Resistance, reactance and body fat percentage was determined with specific formulas available in analyzer, using an electric current of low intensity (800 µAmp) and fixed frequency (50 Khz).

Immediately after the tetrapolar the subjects performed the footpad BIA where they were standing on the analyzer with no shoes, socks, watches, bracelets or similar with legs apart. All procedures were realized with 4h fasting, abstinence from alcohol and physical activity in the last 24h and in rest state. The subjects were instructed to urinate 10 minutes before the data collection.

The data analyses were performed by SPSS 10.0, using paired t test ( $p < 0,05$ ).

### RESULTS

Table 1. Sample characteristics, values expressed in mean (SD).

Age	Height	Weight	BMI
21,6±4,5	175,6±5,1	73,5±8,0	23,9±2,4

It can be observed in Table 1 that the sample showed 21,14,5 yrs and normal BMI (23,92,4 kg/m<sup>2</sup>).

Table 2. Comparison between methods, values expressed in mean (SD).

Tetrapolar %body fat	Footpad %body fat	Tetrapolar fat mass	Footpad fat mass
14,6±3,6*	17,9±5,3*	11,0±3,6	13,5±5,0

\* $p < 0,001$

The footpad method (Table 2) showed higher %body fat mean values compared with tetrapolar method, classified as above average and normal, respectively according the LOHMAN (1992).

Fat mass values have differences of 2,5 kg between methods, with the footpad method overestimating the %body fat up to 3,3% comparing with tetrapolar method. Analyzing the body fat individually, the footpad method presented a difference up to 8% in the %body fat.

### DISCUSSION

The objective of this study was to verify whether there are any methods of body composition by tetrapolar and bipolar

bioelectrical impedance analysis (BIA).

The BIA is a simple widely accepted method to body composition analyses based in bioelectrical conductivity (SUNG et al, 2001). The tetrapolar method is relatively accurate (SUN; FRENCH & MARTIN, 2005) and have shown good correlation compared with other methods for body fat analyses (SUN; CHUMLEA & HEYMSFIELD, 2003; BRACCO et al, 1996; BIAGGI et al 1999; PATEYJOHNS et al, 2006; LUKASKI et al, 1986). Moreover has been widely utilized in body composition research (SUN; CHUMLEA & HEYMSFIELD, 2003) due to be easy to use and fast (SUN; FRENCH & MARTIN, 2005).

The footpad method is popular among health professionals and general public (SUNG et al, 2001). Despite being a validated method in body composition analysis (SUNG et al, 2001; UTTER et al, 1999), there is evidence in literature that bipolar BIA doesn't exactly estimate the %body fat (PATEYJOHNS et al, 2006).

Sung et al. (2001), in comparative study between footpad BIA and DXA in a sample of 49 children, found significant differences ( $p < 0,01$ ) between fat mass. The BIA method overestimated 1,93 Kg the fat mass and 1,65% the %body fat (not significant differences). Parker et al. (2003) compared in 56 boys 10-14 yrs aged body composition using various methods, among them footpad BIA, vs. plethysmography as the gold standard. The BIA significantly overestimated ( $p = 0,001$ ) the fat mass on average 2,34,0kg e %body fat 4,17,2%.

Utler et al. (1999) not found significant differences between footpad BIA and hydrostatic weighing in obese and non-obese subjects, although there is evidence that this method overestimate the fat-free body mass in obese subjects compared to other methods. Chouinard et al. (2007) in their study with 38 overweight subjects not found statistical differences between %body fat mean values measured with footpad BIA and 4-compartment model, but found expressive differences to analyze each individual separately, suggesting caution in this analysis. Pateyjohns et al. (2006) in study of body composition in obese using three different BIA methods, including tetrapolar e bipolar, compared with DXA and found good correlations between methods, however the authors indicate point out limiting the bipolar BIA in the analyses of body fat of a single individual.

### CONCLUSION

This study does not aim to determine the better way to measure %body fat using BIA, however as found in literature, tetrapolar BIA showed more reliable results comparing with bipolar BIA.

The results of this study indicate that the professional must be careful in choosing the method to measure %body fat since we found that both in mean of group and in a single subject the bipolar BIA overestimated the tetrapolar BIA.

More studies can be performed to evaluate other brands and models of BIA analyzers to predict body composition.

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### COMPARISON OF THE PERCENTAGE OF BODY FAT BETWEEN BIOELECTRICAL IMPEDANCE METHODS – TETRAPOLAR VS BIPOLAR

#### ABSTRACT

The accurate estimative of body composition gives important information in physical exercise programs, weight control, maintenance of physiological function, therefore are related to individuals health and quality of life. The objective of this study was to verify whether there are any differences between the results of the evaluation of methods of body composition by tetra polar and bipolar bioelectrical impedance analysis (BIA). The sample consisted of 18 healthy male volunteers between the ages of 21,74,4. These volunteers regularly exercise and show normalcy in their BMI. Tests were carried out on body composition of tetra polar BIA (MALTRON BF-906) and bipolar lower limb (PLENNA TIN-99). Results were collected while the subjects were fasting for 4 hours, abstinent from alcohol and physical activity for 24 hours, rested and urinated 10 minutes prior to the tests. The results indicated significant differences between the BIA methods ( $p < 0.001$ ). The bipolar method presented average values in

the percentage and fat mass (17,95,3%; 13,55,0kg), superior in relation to the tetra polar method (14,63,6%; 11,03,6). This difference caused a divergence in the classification of the rate of fat using the bipolar BIA indicating values above the average, while the tetra polar demonstrated normal values, according to LOHMAN (1992). Looking at each individual's body fat measurement, the bipolar method using the lower limbs showed a difference of up to 8% in relation to the tetra polar method. These findings demonstrated the bipolar method's tendency to hyper estimate the values of the body fat.

**KEYWORDS:** body composition, fitness, bioelectrical impedance.

#### **COMPARAISON ENTRE LE FAT PERCENTAGE ENTRE BIOIMPÉDANCE ELECTRIC – TETRAPOL VC BIPOLAIRE**

##### **RÉSUMÉ**

Une estimation précise de la composition corporelle constitue un élément important dans un programme de conditionnement physique dans le contrôle du poids corporel, le maintien d'un haut niveau de fonctionnement physiologique, liés à la santé et la qualité de vie de l'individu.

Cette étude visait à vérifier s'il existe des différences entre les résultats des méthodes d'évaluation de la composition corporelle par impédance bioélectrique (BIA) tétrapolaire et bipolaire. L'échantillon se composait de 18 hommes volontaires sains âgés de 21,7 à 44 années, les praticiens de l'activité physique régulière et l'IMC a présenté dans les limites normales. Ont été effectuées pour analyser la composition du corps de tétrapolaire BIA (Maltron BF-906) et les troubles bipolaires membres inférieurs (Plenna TIN-99), lors de la collecte de données ont été sujets à jeun pendant 4 heures, l'abstinence d'alcool et l'activité physique pendant 24 heures, le repos et 10 urine minutes avant le test. Les résultats montrent des différences significatives entre les méthodes de BIA ( $p < 0,001$ ). La méthode bipolaire a montré des valeurs moyennes de la masse grasse et le pourcentage (17,9 5,3%, 13,5 5,0 kg) plus élevé que pour la méthode tétrapolaire (14,6 3,6%, 11,0 3,6). Cette différence a entraîné une divergence dans les taux de classification de la graisse avec bipolaire LFI indiquant dessus des scores moyens, tandis que le tétrapolaire montré des valeurs normales, selon LOHMAN (1992). Analyse de la mesure de la graisse du corps dans chaque méthode bipolaire membres inférieurs différer jusqu'à 8% par rapport à la méthode tétrapolaire. Ces résultats démontrent une tendance à surestimer la méthode bipolaire valeurs de la masse grasse corporelle.

**MOTS-CLÉS:** la composition corporelle, la condition physique, d'impédance bioélectrique

#### **COMPARACIÓN DEL PORCENTAJE DE GRASA ANÁLISIS MEDIANTE IMPEDANCIA ELÉCTRICA – TETRAPOLAR VS BIOPOLAR**

##### **RESUMEN**

Una exacta estimación de la composición corporal proporciona un componente importante en un programa de acondicionamiento físico en el control del peso corporal, manteniendo un alto nivel de funcionamiento fisiológico, relacionadas con la salud y la calidad de vida del individuo.

Este estudio tuvo como objetivo verificar si existen diferencias entre los resultados de los métodos de evaluación de la composición corporal por impedancia eléctrica (BIA) tetrapolar y bipolar. La muestra consistió en 18 voluntarios sanos con edades 21,7 a 44 años, practicantes de actividad física regular y con el IMC dentro de los límites normales. Se realizaron análisis de la composición corporal de tetrapolar BIA (MALTRON BF-906) y bipolar de miembros inferiores (Plenna TIN-99). En temas de recolección de datos se mantuvieron en ayuno de 4 horas, abstinencia de alcohol y actividad física durante 24 horas, el descanso y la orina de 10 minutos antes de la prueba. Los resultados indicaron diferencias significativas entre los métodos de BIA ( $p < 0,001$ ). El método bipolar presentó valores medios de masa grasa y el porcentaje (17,9 5,3%, 13,5 5,0 kg) más que el método tetrapolar (14,6 3,6%, el 11,0 3,6). Esta diferencia causó una divergencia en la tasa de clasificación de la grasa con trastorno bipolar BIA indicando valores superiores a la media, mientras que el tetrapolar mostró valores normales, según Lohman (1992). El análisis de la medición de grasa corporal en cada método bipolar de miembros inferiores difieren hasta 8% con respecto al método tetrapolar. Estos datos demuestran una tendencia del método bipolar sobrestimar los valores de grasa corporal.

**PALABRAS CLAVE:** composición corporal, acondicionamiento físico, impedância eléctrica.

#### **COMPARAÇÃO DO PERCENTUAL DE GORDURA ENTRE MÉTODOS DE BIOIMPEDÂNCIA ELÉTRICA – TETRAPOLAR VS BIPOLAR**

##### **RESUMO**

A estimativa precisa da composição corporal proporciona um componente importante em um programa de aptidão física, no controle do peso corporal, na manutenção de um alto nível de funcionamento fisiológico, estando relacionada à saúde e qualidade de vida do indivíduo. Este estudo teve como objetivo verificar se existem diferenças entre os resultados da avaliação da composição corporal pelos métodos de bioimpedância elétrica (BIA) tetrapolar e bipolar. A amostra foi composta de 18 voluntários saudáveis do sexo masculino com idade 21,7,4 anos, praticantes de atividade física regular e apresentando IMC dentro dos padrões de normalidade. Foram realizadas análises de composição corporal de BIA tetrapolar (MALTRON BF-906) e bipolar de membros inferiores (PLENNA TIN-99), durante as coletas os indivíduos estavam em jejum de 4h, abstinência alcoólica e atividade física por 24h, repouso e urina 10 minutos antes dos testes. Os resultados indicaram diferença significativa entre os métodos de BIA ( $p < 0,001$ ). O método bipolar apresentou valores médios de percentual e massa de gordura (17,95,3%; 13,55,0kg) superiores em relação o método tetrapolar (14,63,6%; 11,03,6). Esta diferença causou uma divergência na classificação da taxa de gordura com a BIA bipolar indicando valores acima da média, enquanto a tetrapolar mostrou valores normais, segundo LOHMAN (1992). Analisando a medida da gordura corporal em cada indivíduo o método bipolar de membros inferiores apresentou diferença de até 8% em relação ao método tetrapolar. Estes achados demonstraram uma tendência do método bipolar hiperestimar os valores de gordura corporal.

**PALAVRAS-CHAVE:** composição corporal, aptidão física, impedância bioelétrica.