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# ARTÍCULOS ORIGINALES

## DETERMINACIÓN DE COMPOSICIÓN CORPORAL MEDIANTE ANÁLISIS DE IMPEDANCIA SEGMENTADA: CONSIDERACIONES Y APLICACIONES PRÁCTICAS

### DETERMINATION OF BODY COMPOSITION BY SEGMENTAL BIOELECTRICAL IMPEDANCE ANALYSIS: CONSIDERATIONS AND PRACTICAL APPLICATIONS

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#### ABSTRACT

*Introduction: Bioelectrical impedance is a fast, inexpensive, easy, portable, and noninvasive method. A major innovation in the analysis of body composition is segmental bioelectrical impedance. Objectives: To assess the applicability of segmental bioelectrical impedance. Subjects and methods: The study was conducted on female subjects divided into two groups: Group I (n = 8) consisted of healthy women and group II (n=25) of obese women with Polycystic Ovary Syndrome (PCOS). All subjects were submitted to examination by total and segmental bioelectrical impedance. Results and discussion: Anthropometric parameters (weight, BMI, total lean mass and total fat mass) showed significant differences between groups. There was a significant difference between groups I and II for all body segments evaluated, except for lean mass of the leg. Conclusion: Procedures of segmental bioelectrical impedance will be increasingly useful in the nutritional assessment of tissue masses, enabling more sensitive assessment and monitoring of nutritional care.*

*Key words: segmental bioelectrical impedance, body composition, abdominal obesity, polycystic ovary syndrome.*

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#### INTRODUCTION

The determination of body composition is very important in clinical practice and in nutritional evaluation of populations, mainly due to the association of body fat with various metabolic changes (1,2). Thus, there is a need for methods that can assess in a precise and reliable manner the amount of body fat in relation to total body mass, as well as its body distribution. Among the techniques used for these purposes are computed tomography (3), magnetic resonance, bioelectrical impedance, skin fold thickness, dual energy X-ray absorptiometry (DXA)

(4), and hydrostatic weighing, the last two being considered "gold standards" for validation studies.

Methods such as computed tomography, magnetic resonance, DXA and hydrostatic weighing, despite producing accurate results, are very expensive and not available at most institutions. On the other hand, bioelectrical impedance is a method extensively used by nutritionists to assess body composition in clinical practice since it is rapid, easy, portable, noninvasive, less expensive, and applicable to individuals of various ages (5,6)

The principles of bioelectrical impedance are based

on the passage of a low-amplitude and high-frequency current measuring resistance ( $R_e$ ), reactance ( $X_c$ ), impedance ( $Z$ ), and the phase angle ( $\phi$ ) (5). In simpler terms, lean tissues, by containing large amounts of water and electrolytes, are high conductors of electrical current and therefore present low resistance. Conversely, fat and bone are poor conductors containing smaller amount of fluids and electrolytes and having greater electrical resistance. The resistance and reactance values obtained can be used to estimate body composition by means of predictive equations.

Based on these same principles, an important innovation has been produced, called segmental bioelectrical impedance. Chumlea et al (7) showed that specific assessment of arm, leg and trunk resistance could be used to calculate total fat-free mass in a direct manner and Baumgartner et al (8) demonstrated that the phase angle (reactance/resistance ratio) of the trunk was significantly correlated with percent total body fat. In addition, Settle et al (9) suggested that total body resistance could be estimated based on arm or leg resistance. On this basis, Baumgartner et al (10) concluded that it would be possible to accurately predict body composition by measuring the length and resistance of some body segments such as the arm, leg, and trunk.

This method applied to segments represents a great advance in clinical practice by overcoming the limitations of traditional bioelectrical impedance analysis, permitting the analysis of body composition in patients with renal (11) or hepatic (12) diseases that culminate in the presence of edema or ascites or that involve tissue deposition or depletion (muscle or fat) in specific body segments (13), for example.

In view of the above considerations, the objective of the present communication is to describe in detail segmental bioelectrical impedance analysis for the arm, trunk and leg, showing the practical applications of these measurements in the assessment of body composition.

## SUBJECTS AND METHODS

### Study design

The study was conducted on women submitted to total and segmental bioelectrical impedance analysis (Biodynamics 310. 800  $\mu$ A and 50 kHz), with the evaluation of body segments (arm, trunk and leg) according to the standardized techniques described below (10). Weight, total height, acromion length, sitting height, and arm length were measured according to standardized techniques (10,14).

The participants were divided into two groups: group I (n=8) consisted of women considered eutrophic on the basis of BMI (18,5 a 24,9 Kg/m<sup>2</sup>), according to the

classification proposed by the World Health Organization (14,15) and group II (n=25) consisted of obese women, based on a BMI of > 30.0 kg.m<sup>-2</sup>, with a diagnosis of Polycystic Ovary Syndrome (PCOS) according to the definition of the Rotterdam Consensus, i.e., presence of at least 2 of the 3 following characteristics: oligo- or anovulation, clinical and/or biochemical signs of hyperandrogenism and polycystic ovaries, together with the exclusion of other etiologies (16). This group was selected based on the fact that women with PCOS tend to have a larger amount of total body fat than women without the syndrome. In addition their body fat distribution is differentiated, with a greater concentration in the abdominal region (17).

For the analysis and later comparison of the anthropometric characteristics of the above groups, a third group was used (group III) as described by Baumgartner et al (1989) (10), which consisted of eutrophic individuals of both genders according to BMI classification, although only the data for the female populations were used here as a criterion of comparison. Despite this group has a higher mean age it was used in order to establish some comparisons with other study groups because the group III is part of the sample of one of the most representative works on segmental bioelectrical impedance described in the literature.

Data for the two experimental groups are reported as absolute means + SD and were analyzed statistically by ANOVA followed by the Tukey post hoc test. The nonparametric Mann-Whitney test for unpaired samples was used for the comparison of the total and segmental body composition data between groups I and II. The level of significance was set at  $p < 0.05$  in all analyses.

### Positions for the measurements of body lengths

Specific anatomical points were defined for the determination of segment length based on the scientific literature:

- **Height** – height was measured with the subject standing, barefoot and with the head and neck aligned with the trunk (18);
- **Arm** – arm length was measured from the most distal point of the third metacarpus to the acromion with the arm fully extended (7);
- **Trunk** – trunk length was calculated by the difference between the length measured from the acromion and the length of the leg (10);
- **Leg** – leg length was calculated by the difference between total height and sitting height (10).

### Anatomical points for electrode placement

In addition to the length measurements, new ana-

tomical points were defined for electrode placement according to each body segment:

- **Arm** – one pair of electrodes must be located in the standard position, one on the hand and the other at a distance of 5 cm from the wrist; the other pair of electrodes must be located in the acromial process and in the axillary fold (7);
- **Trunk** – the first pair of electrodes must be located on the anterior midline of the proximal thigh, with the “receiving” electrode on the same plane as the gluteal fold and the “source” electrode 5 cm distal to the “receiving” electrode. In the second pair, the “receiving” electrode must be located above the sternal cleft and the “source” electrode on the anterior midline of the neck 5 cm from the skull (10);
- **Leg** - one pair of electrodes must be located on the anterior midline of the proximal thigh, one of them on the ankle and the other at a 5 cm distance on the foot (10).

The values obtained were inserted into predictive equations for fat and fat-free mass specific for each body segment (table 1).

**RESULTS AND DISCUSSION**

Except for height (cm) and arm length (cm), the other parameters evaluated (age, weight, BMI, trunk and leg length, total lean mass, and total fat mass) differed significantly between all groups. In terms of the general characteristics of the three groups, it can be seen that group I was the youngest (23.3 ± 1.0 years) and had a mean BMI close to that of the group analyzed by Baumgartner et al. However, group I presented a reduced total

fat mass (13.9 ± 2.5 kg) compared to groups II and III (42.5 ± 8.3 kg and 30.2 ± 8.8 kg, respectively) (table 2). Considering the body fat it was expected that the group I presented lower values since it is composed of a sample of young women with a BMI within the normal range. However, group II included women with PCOS, being a common clinical manifestation of this disease increased body fat. Finally, group III despite being composed of women with a BMI in the eutrophic, they have a higher age group, which favors an increase in body fat, since it is known that the aging contributes to reduced lean body mass and increased fat mass

The crude resistance and reactance values obtained for the three groups are presented in table 3. The values of these parameters for groups I and II would be expected to be significantly different in view of the differences in body constitution existing between the three groups. However, this was not the case for the trunk even though group II consisted of obese women with PCOS who, due to their clinical situations, tend to accumulate more fatty tissue in this region. This region contains 46% of body mass but accounts for only 8% of total impedance, whereas the upper limbs (arms) contain 4% of body mass (19) but account for 45% of total impedance. As an explanation of this fact, Organ et al (20) propose that the trunk makes a small contribution to total impedance. Due to these discrepancies, Organ et al stated that trunk impedance should be separated from limb impedance since total impedance “virtually” excludes this region (20).

On the basis of resistance and reactance values, it was possible to estimate the fat-free mass (kg) and total

**TABLE 1**

**Equations for the calculation of fat mass (%) and fat-free mass (kg) for the female gender (10).**

| Segment              | Equation                                                                      |
|----------------------|-------------------------------------------------------------------------------|
| <b>FAT MASS</b>      |                                                                               |
| ARM                  | - 8.20 + [8.13 x (body weight x arm resistance /arm length <sup>2</sup> )]    |
| TRUNK                | 17.26 + [7.39 x (body weight x trunk resistance /trunk length <sup>2</sup> )] |
| LEG                  | - 0.53 + [9.78 x (body weight x leg resistance /leg length <sup>2</sup> )]    |
| <b>FAT-FREE MASS</b> |                                                                               |
| ARM                  | 1.17 + 0.077 x arm length <sup>2</sup> / impedance index*                     |
| TRUNK                | 15.9 + 0.153 x trunk length <sup>2</sup> / impedance index*                   |
| Leg                  | 4.2 + 0.088 x leg length <sup>2</sup> / impedance index*                      |

\* impedance index= Height (cm)<sup>2</sup> / Total Resistance

and segmental fat mass (%) of groups I and II by means of previously described equations (table 4). The results show that there was a significant difference between the two groups evaluated regarding all body segments, except for the lean mass of the leg, which did not differ

between groups. A possible explanation would be the fact that group I women are younger and therefore have a greater amount of lean mass, with even higher values if they practice some type of physical activity. In addition, we may assume that the leg region is not one of the first

TABLE 2

Comparison of the anthropometric characteristics of group I (eutrophic), group II (obese with PCOS) and group III (Baumgartner et al, 1989).

| Variables<br>N           | Group I<br>8 | Group II<br>25 | Group III<br>72 | P        |
|--------------------------|--------------|----------------|-----------------|----------|
| Age (years)              | 23.3 ± 1.0a  | 30.7 ± 5.2b    | 36.1 ± 11.1a.b  | < 0.05   |
| Weight (kg)              | 56.2 ± 5.2a  | 93.9 ± 14.0b   | 62.7 ± 13.1b    | < 0.0001 |
| Height (cm)              | 164.7 ± 5.8  | 160.2 ± 6.7    | 165.1 ± 5.9     | NS       |
| BMI (kg/m <sup>2</sup> ) | 20.7 ± 1.5 a | 36.5 ± 4.4 b   | 23.02 ± 4.8 b   | < 0.0001 |
| Arm length (cm)          | 73.1 ± 3.8   | 70.5 ± 4.5     | 62.9 ± 2.5      | NS       |
| Trunk length (cm)        | 59.6 ± 1.7 a | 49.0 ± 3.9 b   | 58.32 ± 3.1 b   | < 0.0001 |
| Leg length (cm)          | 76.8 ± 4.3   | 85.2 ± 5.3     | 76.85 ± 3.7     | 0.0015   |
| Total fat mass (kg)      | 13.9 ± 2.5a  | 42.5 ± 8.3b    | 30.2 ± 8.8 a.b  | < 0.0001 |
| Total lean mass (kg)     | 42.3 ± 3.0a  | 52.4 ± 6.0 b   | 43.0 ± 5.4 b    | < 0.0001 |

Legend: a: group I versus group III; b: group II versus group III; NS- non significant

TABLE 3

Comparison of the segmental resistance and reactance of group I (eutrophic), group II (obese with PCOS) and group III (Baumgartner et al, 1989).

| Segment      | Group I       | Group II         | Group III         | P       |
|--------------|---------------|------------------|-------------------|---------|
| <b>TOTAL</b> |               |                  |                   |         |
| Resistance   | 669.3 ± 44.7a | 504.42 ± 55.39.b | 595.67 ± 64.02a.b | < 0.01  |
| Reactance    | 72.4 ± 5.4a   | 58.36 ± 11.62b   | 67.57 ± 8.50 a.b  | 0.0071  |
| <b>ARM</b>   |               |                  |                   |         |
| Resistance   | 319.4 ± 21.9a | 234.66 ± 34.0b   | 301.03 ± 38.07a.b | < 0.001 |
| Reactance    | 30.0 ± 2.3    | 25.17 ± 4.41a    | 34.83 ± 7.02a     | < 0.001 |
| <b>TRUNK</b> |               |                  |                   |         |
| Resistance   | 84.0 ± 11.6   | 96.56 ± 16.69    | 93.60 ± 28.80     | NS      |
| Reactance    | 14.5 ± 3.4    | 13.58 ± 4.31     | 14.69 ± 4.11      | NS      |
| <b>LEG</b>   |               |                  |                   |         |
| Resistance   | 284.5 ± 25.0a | 230.92 ± 26.14b  | 296.26 ± 34.07a.b | < 0.001 |
| Reactance    | 41.9 ± 6.6a   | 30.97 ± 5.54b    | 39.61 ± 6.58a.b   | < 0.001 |

Legend: a: group I versus group III; b: group II versus group III; NS – non significant

to be affected by changes related to tissue depletion and/or deposition in a special situation of altered body composition (as is the case for PCOS). Group II individuals presented greater percentages of fat mass in all body segments evaluated. These results were expected since group II consisted of women classified as obese, with significantly greater weight and higher BMI compared to group I. In addition, group I was younger and it is known that individuals of both genders of more advanced age tend to present a greater accumulation of body fat.

Regarding the equations used to estimate fat mass, there was no significant difference between fat mass (kg) obtained by total bioelectrical impedance and fat mass (kg) obtained as the sum of the three body segments analyzed in group II ( $42.5 \pm 8.3$  kg x  $44.1 \pm 13.5$  kg,  $p=0.9$ ), so that correlations between segmental fat mass and total fat mass could be established in future studies (table 4). Lean mass (kg) showed a similar behavior, with no significant difference in total lean mass obtained by impedance and lean mass obtained by the sum of the body segments evaluated ( $51.4 \pm 6.0$  kg x  $48.6 \pm 3.6$  kg,  $p=0.09$ ).

However, in group I (eutrophic) the total fat mass (kg) and fat mass (kg) obtained by the sum of the three body segments ( $13.9 \pm 2.5$  kg x  $10.1 \pm 2.2$  kg,  $p=0.014$ ) as well as the total lean mass and lean mass obtained by the sum of the body segments ( $42.3 \pm 3.0$  kg x  $57.7 \pm$

$3.2$  kg,  $p=0.002$ ) showed significant differences (table 4). The fat mass evaluated by the sum of the leg, trunk and arm segments underestimated by 72.7% the fat mass evaluated by total bioelectrical impedance, while the lean mass evaluated by the sum of the segments was overestimated by 36% in relation to the lean mass obtained by total bioimpedance. The application of formulas to distinct groups regarding age and body composition may help explain these differences. The equations for the estimate of lean mass used here were described by Bracco et al (21) in a study in which the formulas were developed based on a population of women predominantly showing excess weight (mean weight:  $75.3 \pm 3.1$  kg and BMI:  $27.8 \pm 1.2$  kg.m<sup>-2</sup>), i.e., a sample with anthropometric characteristics differing from those of group I of the present study (eutrophic women), in addition to the fact that the sample size of this group was smaller. These factors may justify the need to develop specific equations for the evaluation of body tissues in groups with different characteristics from those used in the elaboration of these described equations.

Several studies using segmental bioelectrical impedance analyzed the sum of the resistance and reactance of the three body segments (arm, trunk and leg), and the authors presented some proposals (table 5). Organ et al (20) validated the proposition that the sum of the resistance values of the three body segments should be

**TABLE 4**  
**Comparison of fat-free mass (kg) and fat mass (%) estimates of group I (eutrophic) and group II (obese with PCOS).**

| Segment      | Group I        | Group II       | p        |
|--------------|----------------|----------------|----------|
| <b>TOTAL</b> |                |                |          |
| FFM*         | $42.3 \pm 3.0$ | $51.4 \pm 6.0$ | < 0.0001 |
| FM*          | $24.6 \pm 2.2$ | $45.0 \pm 2.3$ | < 0.0001 |
| <b>ARM</b>   |                |                |          |
| FFM          | $11.3 \pm 1.1$ | $8.7 \pm 1.3$  | < 0.0001 |
| FM           | $19.1 \pm 1.6$ | $27.6 \pm 4.9$ | < 0.0001 |
| <b>TRUNK</b> |                |                |          |
| FFM          | $29.3 \pm 1.2$ | $23.1 \pm 1.3$ | < 0.0001 |
| FM           | $27.0 \pm 1.0$ | $46.2 \pm 9.4$ | < 0.0001 |
| <b>LEG</b>   |                |                |          |
| FFM          | $17.0 \pm 1.3$ | $16.8 \pm 1.8$ | NS       |
| FM           | $26.0 \pm 3.1$ | $28.4 \pm 2.8$ | 0.044    |

Legend: FFM – Fat-free mass in kg; FM – Fat mass as %; NS – non significant

equal to the resistance obtained with total bioimpedance analysis. Similar validations were not reached by other investigators: Baumgartner et al (10) reported that the sum of the segments was 16% higher than total resistance and Fuller & Elia (22) stated that the sum of the segments was 7-12% higher for women. In the present study we detected values similar to those proposed by Bracco et al (21) for group I (a sum  $2.8 \pm 2.9\%$  higher than total resistance), whereas the values obtained for group II were closer to those proposed by Fuller & Elia (22) (a sum  $9.4\% \pm 6.5$  higher than total resistance) (table 5).

Segmental bioelectrical impedance, in addition to permitting the visualization of the contribution of each body segment in relation to the total, also overcomes some barriers in clinical practice, especially by being correlated with total impedance. Thus, this evaluation permits the determination of lean mass and fat mass in individuals presenting characteristics that are considered to be exclusion criteria for this technique.

This segmental evaluation of body fat is important because of the existence of different metabolic behaviors between adipose tissue located in the upper and lower regions of the body, and the recommendation is not to

quantitate simply total body weight or total body fat.

Adipose tissue is an organ responsible for the secretion of various factors named adipokines which are directly or indirectly related to processes involved in the development of insulin resistance, type II diabetes, arterial hypertension, and cardiovascular diseases (CVD) (24). Abdominal obesity is the central component of metabolic syndrome and individuals with this syndrome are at higher risk for morbidity and mortality due to CVD. The accumulation of visceral fat is more associated with metabolic risks than BMI or subcutaneous fat (25).

Thus, Snijder et al. (2004) (26) assessed the influence of fatty and muscle tissue of the region of the trunk and leg on glucose metabolism and observed a positive association between trunk fat and fasting glycemia levels, glycemia levels after a glucose overload and HOMA-IR index, as opposed to a negative association between leg fat and fasting glycemia and HOMA-IR index. In addition, waist circumference presented a strong positive correlation with trunk fat ( $r = 0.82$ ,  $p < 0.0001$ ), revealing the existence of a correlation between trunk fat and abdominal fat (26).

The assessment of body fat compartmentalization is

**TABLE 5**
**Segmental bioimpedance (50 kHz) assessed by various investigators.**

| Reference*                  | Total    | Arm      | Trunk     | Leg        | Sum      | % in relation to the total |
|-----------------------------|----------|----------|-----------|------------|----------|----------------------------|
| <b>Resistance</b>           |          |          |           |            |          |                            |
| Chumlea et al (7)           | 588 ± 52 | 295 ± 39 | 86 ± 19   | 287 ± 35   | 688      | 117                        |
| Chumlea et al (23)          | 601 ± 66 | 303 ± 38 | 93 ± 27   | 299 ± 34   | 695      | 116                        |
| Baumgartner et al (10)      | 596 ± 64 | 301 ± 38 | 94 ± 29   | 296 ± 34   | 691      | 116                        |
| Organ et al (20)            | 594 ± 54 | 280 ± 31 | 51 ± 8    | 266 ± 25   | 597      | 100.5                      |
| Bracco et al (21)           | 460 ± 57 | 221 ± 36 | 45 ± 6    | 196 ± 25   | 463 ± 57 | 1005 ± 1.9                 |
| Presente estudio – group I  | 669 ± 45 | 319 ± 22 | 84 ± 11,6 | 284,5 ± 25 | 687      | 103                        |
| Presente estudio – group II | 504 ± 55 | 235 ± 34 | 96 ± 17   | 231 ± 26   | 562      | 109                        |
| <b>Reactance</b>            |          |          |           |            |          |                            |
| Chumlea et al (7)           | 65 ± 12  | 33 ± 8   | 13 ± 4    | 39 ± 8     | 84       | 129                        |
| Organ et al (20)            | 67 ± 12  | 25 ± 6   | 7 ± 2     | 36 ± 7     | 68       | 101.4                      |
| Baumgartner et al (10)      | 67 ± 8   | 35 ± 7   | 15 ± 4    | 40 ± 7     | 90       | 134                        |
| Bracco et al (21)           | 78 ± 13  | 31 ± 8   | 10 ± 3    | 37 ± 6     | 75 ± 14  | 99.9 ± 7.8                 |
| Present study – group I     | 72 ± 5   | 30 ± 2   | 14 ± 3    | 42 ± 7     | 86       | 119                        |
| Present study – group II    | 58 ± 12  | 25 ± 4   | 13 ± 4    | 31 ± 5     | 69       | 119                        |

Legend: \* All values reported in the references correspond to female subjects.

especialmente importante em certas situações clínicas, tais como a síndrome dos ovários policísticos (PCOS). Uma das principais características desta síndrome é a tendência à acumulação de gordura na região superior do corpo, tanto em obesos quanto em eutróficos (27). Um estudo avaliando a distribuição de gordura corporal em eutróficos com PCOS comparados a eutróficos sem PCOS (pareados por idade, peso e IMC) detectou que os pacientes com PCOS tinham uma maior quantidade de gordura total no corpo ( $35.7 \pm 7.6\%$  vs  $26.4 \pm 3.5\%$ ;  $p = 0.002$ ) e de gordura na região superior do corpo ( $9.1 \pm 3.3$  vs  $4.5 \pm 1.1$  kg;  $p = 0.001$ ), sem diferença na quantidade de gordura localizada na região inferior do corpo (28).

### CONCLUSÃO

Apresentamos aqui os procedimentos e fórmulas mais apropriados para o uso da impedância bioelétrica aplicada aos segmentos do braço, tronco e perna, considerando que seu uso é amplamente disseminado, mas ainda não padronizado. Deve-se ressaltar que não houve validação das técnicas descritas aqui, mas apenas uma compilação dos procedimentos e fórmulas já descritos na literatura e a descrição de uma aplicação prática. Com base nos dados do presente estudo, pode-se observar que fórmulas e procedimentos específicos devem ser desenvolvidos, para que futuros estudos possam ser realizados para validar essas técnicas de impedância bioelétrica em situações clínicas específicas nas quais ocorre depleção/deposição de tecido em segmentos corporais, a fim de obter avaliações mais sensíveis e monitoramento do cuidado nutricional.

### RESUMO

**Introdução:** A impedância bioelétrica é um método rápido, barato, fácil, portátil e não invasivo. Uma grande inovação na análise da composição corporal é a Impedância Bioelétrica Segmentar. **Objetivos:** Avaliar a aplicabilidade da impedância bioelétrica segmentar. **Sujeitos e Métodos:** o estudo foi realizado com indivíduos do sexo feminino, divididos em: Group I (n=8) composto por mulheres eutróficas e o Group II (n=25) mulheres obesas com Síndrome do Ovário Policístico (SOP). Todos os indivíduos foram submetidos ao exame de impedância bioelétrica total e segmentar. **Resultados e discussão:** Os parâmetros antropométricos de peso, IMC, massa magra total e massa gorda total apresentaram diferenças significativas entre os grupos. Houve diferença significativa para todos os segmentos corporais avaliados, com exceção da massa magra da perna entre o group I e II. **Conclusão:** Procedimentos de impedância bioelétrica segmentar serão cada vez mais úteis na avaliação nutricional de massas teciduais, possibilitando avaliações e monitoramentos mais sensíveis do cuidado nutricional.

**Termos chave:** bioimpedância elétrica segmentar, composição corporal, obesidade abdominal, síndrome do ovário policístico.

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### BIBLIOGRAFÍA

1. Lenz M, Richter T, Mühlhauser, I. The morbidity and mortality associated with overweight and obesity in adulthood. *Dtsch Arztebl Int* 2009, (106) 40: 641-8.
2. Stevens J, Katz EG, Huxley RR. Associations between gender, age and waist circumference. *Eur J Clin Nutr* 2009, 1-10.
3. Kuk JL, Saunders TJ, Davidson LE, Ross R. Age-related changes in total and regional fat distribution. *Ageing Res Rev*, 2009.
4. Rothney MP, Brychta, R J, Schaefer EV, Chen KY, Skarulis MC. Body Composition Measured by Dual-energy X-ray Absorptiometry Half-body Scans in Obese Adults Obesity (Silver Spring) 2009; 17 (6): 1281-1286.
5. Lukaski HC, Johnson PE, Bolonchuk WW, Lykken GI. Assessment of fat-free mass using bioelectrical impedance measurements of the human body. *Am J Clin Nutr* 1985;41(4): 810-7.
6. Roche AF, Chumlea WC, Guo S. Identification and validation of new anthropometric techniques for quantifying body composition. Natick, MA: US Army Research and Development Center, 1986.
7. Chumlea WC, Baumgartner RN, Roche AF. Specific resistivity to estimate fat-free mass from segmental body measures of bioelectric impedance. *Am J Clin Nutr* 1988; 48(1): 7-15.
8. Baumgartner RN, Chumlea WC, Roche AF. Bioelectric impedance phase angle and body composition. *Am J Clin Nutr* 1988; 48(1): 16-23.
9. Settle RG, Foster KR, Epstein BR, Muller JL. Nutritional assessment: whole body impedance and body fluid compartments. *Nutr Cancer* 1988; 2: 72-80.
10. Baumgartner RN, Chumlea WC, Roche AF. Estimation of body composition from bioelectric impedance of body segments. *Am J Clin Nutr* 1989; 50(2):

- 221-6.
11. Park J, Yang WS, Kim S B, Park SK, Lee SK, Park JS, Chang, J. W. Usefulness of segmental bioimpedance ratio to determine dry body weight in new hemodialysis patients: a pilot study. *Am J Nephrol.* 2009; 29(1): 25-30.
  12. Schloerb PR, Forster J, Delcore R, Kindscher JD. Bioelectrical impedance in the clinical evaluation of liver disease. *Am J Clin Nutr.* 1996; 64: 510S-514S.
  13. Schwenk A, Breuer P, Kremer G, Ward L. Clinical assessment of HIV-associated lipodystrophy syndrome: bioelectrical impedance analysis, anthropometry and clinical scores. *Clin Nutr* 2001; 20 (3): 243 – 9.
  14. ORGANIZAÇÃO MUNDIAL DA SAÚDE – OMS. Physical status: the use and interpretation of anthropometry. Genebra, 1995.
  15. ORGANIZAÇÃO MUNDIAL DA SAÚDE – OMS. Obesity: preventing and managing the global epidemic. Genebra, 1997.
  16. Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group 2004 Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome. *Fertil Steril.* 2004; 81(1): 19–25.
  17. Norman RJ, Davies MJ, Lord JL, Moran LJ. The role of lifestyle modification in polycystic ovary syndrome. *TRENDS Endocrinol & Metab.* 2002; 13(6): 251-7.
  18. Heymsfield SB. Anthropometric measurements: application in hospitalized patients. *Infusionstherapie* 1990; 17: 48-51.
  19. Clarys JP, Marfell-Jones MJ. Anatomical segmentation in humans and the prediction of segmental masses from intra-segmental anthropometry. *Hum Biol* 1986; 58: 771 – 82.
  20. Organ LW, Bradham GB, Gore DT, Lozier SL. Segmental bioelectrical impedance analysis: theory and application of a new technique. *J Appl Physiol* 1994; 77(1): 98 – 112.
  21. Bracco D, Thiébaud D, Chioloro RL, Landry M, Burckhardt P, Schutz Y. Segmental body composition assessed by bioelectrical impedance analysis and DEXA in humans. *J Appl. Physiol* 1996; 81(6): 2580-7.
  22. Fuller NJ, Elia M. Potential use of bioelectrical impedance of the “whole body” and of body segments for the assessment of body composition: comparison with densitometry and anthropometry. *Eur J Clin Nutr* 1989; 43(11): 779 – 791.
  23. Chumlea WC, Baumgartner RN, Mitchell CO. The use of segmental bioelectric impedance in estimating body composition. In: *Advances in In Vivo Body Composition Studies*, edited by S. Yasumura. New York: Plenum, 1999: 375- 85.
  24. Hermsdorff HHM, Monteiro JBR. Gordura visceral, subcutânea ou intramuscular: onde está o problema? *Arq Bras Endocrinol Metab* 2004; 48(6): 803-11.
  25. Ryo M, Maeda K, Onda T, Katashima M, Okumiya A, Nishida M, et al. A new simple method for the measurement of visceral fat accumulation by bioelectrical impedance. *Diabetes Care* 2005; 28(2): 451-3.
  26. Snijder MB, Dekker JM, Visser M, Bouter LM, Stehouwer CDA, Yudkin JS, et al. Trunk fat and leg fat have independent and opposite associations with fasting and postload glucose levels. *Diabetes Care* 2004; 27(2): 372-7.
  27. Tafeit E, Moller R, Rackl S, Giuliani A, Urdl W, Freytag U, et al. Subcutaneous adipose tissue in lean and obese women with polycystic ovary syndrome. *Exp Biol Med.* 2003; 228(6): 710-716.
  28. Kirchengast S, Huber J. Body composition characteristics and body fat distribution in lean women with polycystic ovary syndrome. *Human Reproduction* 2001; 16(6): 1255-1260.