

Ripka, W.L.; Rotta, C.V.; Ulbricht, L. y Neves, E.B. (2014). Composición corporal evaluada por pliegues cutáneos y bioimpedancia en varones militares brasileños / Body composition evaluated by skinfolds, bioimpedance and body mass index in adults. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 14 (54) pp. 279-289. [Http://cdeporte.rediris.es/revista/revista54/artcomposicion461.htm](http://cdeporte.rediris.es/revista/revista54/artcomposicion461.htm)

ORIGINAL

BODY COMPOSITION EVALUATED BY SKINFOLDS AND BIOIMPEDANCE IN BRAZILIAN MEN SOLDIERS

COMPOSICIÓN CORPORAL EVALUADA POR PLIEGUES CUTÁNEOS Y BIOIMPEDANCIA EN VARONES MILITARES BRASILEÑOS

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ACKNOWLEDGEMENTS

We thank CAPES for the scholarship funding Masters Program Graduate in Electrical Engineering and Industrial Informatics (CPGEI) of the Federal Technological University of Paraná (UTFPR)

Codigo UNESCO: 2402.03 Antropometría y Antropología Forense / Anthropometry and Forensic Anthropology.

Clasificación del Consejo de Europa: 09 Cineantropometría / Kinanthropometry

Recibido 18 de noviembre de 2011 **Received** November 18, 2011

Aceptado 28 de enero de 2013 **Accepted** January 28, 2013

ABSTRACT

The aim of this study was to compare body composition by skinfold thickness (DC) by bioelectrical impedance analysis (BIA) and body mass index (BMI). Research was carried out with 153 soldiers with the equipment: balance Wiso; WCS stadiometer; adipometer Cescorf Malton scientific and BF-900 to bioelectrical impedance analysis. Body density was obtained by the equation of Jackson&Pollock and classification of the percentage of fat by following Pollock&Wilmore. To check the correlation was used Spearman's test. The average results (\pm standard deviation) found for age, weight, height and BMI were: 19 years (\pm 1.8years), 70.9 kg (\pm 9.55), 1.74 meters (\pm 0.06) and 23.9 kg/m² (\pm 2.76), respectively. The fat percentage by BIA and DC were respectively 12.78 (\pm 5.45) and 16.29 (\pm 4.02). Concluded that body composition by the method of DC, BIA and BMI have data that correlate, and the use of bioimpedance was indicated in most groups whose fat percentage ranged around 18-20%.

KEYWORDS: Body composition, bioimpedance, skinfolds thickness, BMI.

RESUMEN

El objetivo de este estudio fue comparar la composición corporal por doblas cutáneas (DC) por bioimpedancia eléctrica(BIA) y el índice de masa corporal(IMC). Se hizo un trabajo de campo con 153 militares usando los siguientes equipos: balanza Wiso; estadiómetro WCS; adipómetro Cescorf científico y Malton BF-900 para bioimpedancia eléctrica. La densidad corporal se consiguió por la ecuación de Jackson&Pollock y la clasificación del porcentaje de grasa corporal siguiendo Pollock&Wilmore. Para verificar la correlación se usó el test de Spearman. Los resultados promedios (\pm desviación estándar) hallados para edad, peso, estatura e IMC, fueron: 19 años (\pm 1,8 años), 70,9Kg (\pm 9,55), 1,74 metros (\pm 0.06) y 23,9 kg/m² (\pm 2,76) respectivamente. El porcentaje de grasa corporal por DC y BIA fueron respectivamente 12,78 (\pm 5,45); 16,29 (\pm 4,02). Concluí que la composición corporal por el método de DC, BIA e IMC presentó datos que se correlacionan, siendo que el uso de la bioimpedancia fue más indicada en grupos cuyo porcentaje de grasa corporal variaba entre 18-20%.

PALABRAS CLAVE: Composición corporal, bioimpedancia eléctrica, pliegues cutáneos, IMC.

INTRODUCTION

The assessment of body fat is one of the most studied morphological variables in kinanthropometry and is included as a component of the Health Related Physical Fitness ⁽¹⁾. The relevance of this theme comes from data from the World Health Organization - WHO ⁽²⁾ pointing excess body fat (obesity) as the epidemic of the XXI century, because it is a triggering factor for many disorders

for humans, such as: cardiovascular disease, diabetes, decreased respiratory capacity and even cancer ^(3,4).

The diagnosis of obesity is made by assessing body composition (CP), which seeks through techniques and equipment, detect physiological abnormalities in the human body, and these measures has been proven to be a potential source of study, since it quantifies the human body components ⁽⁵⁾. The authors highlight the skinfold technique (SF) and the use of indices related to body weight by height (BMI) as the most commonly used for estimation of subcutaneous fat. Other more sophisticated methods such as Tomo, MRI, hydrostatic weighing, bioelectrical impedance analysis (BIA), dual energy X - ray absorptiometry (DEXA) and ultrasound ^(6,7) may also be examples of tools for analysis of body composition ⁽⁸⁾ however, in many cases, are impractical for the Brazilian economic reality.

The BMI, a measure of body fat based on height and weight, is set by WHO as a useful tool for epidemiological purposes and in situations of lack of equipment for detecting obesity, however this Data shows no strong correlation with the actual body fat ⁽⁹⁾ and, using this method as the only tool in detecting abnormalities in a population that has high intensity of physical exercise is quite inconvenient because the method cannot differentiate between muscle mass from fat mass ⁽¹⁰⁾.

The measurement of body fat by skinfold is considered a less expensive non-invasive method of quickly and easily measures in order to interpret the results ⁽¹¹⁾. This is done using a compass -type clamp, where it works with the same principle as micrometer, used to measure the distance between two points ⁽¹²⁾, which are estimated millimeters of fat in the subcutaneous layer deposited by different folds skin. The limitation of this method is primarily on the ability of the evaluator because their experience is a key factor in the accuracy of data, secondly getting fat percentage (BFP) depends on the choice of a wide variety of equations which can make the result more or less accurate.

Other equipment used in the evaluation of CP is bioelectrical impedance analysis, which is a quick, non-invasive and not so high cost method ⁽¹³⁾. The procedure for the measurement of body composition is the passage of an electric current of low intensity through electrodes placed on the body of reported associated with the impedance (resistance and reactance values to current flow). Body components offer different resistances; lean tissues have high carrying capacity due to the high presence of water and electrolytes, the opposite is detected in adipose and bone tissues ^(7, 11, 14).

The Brazilian army requires its members basic physical conditions necessary to perform specific military functions ⁽¹⁵⁾. The C20 - 20 ⁽¹⁵⁾ is the official documentation that states the parameters and norms about physical activity and amount of GC % of this population, as they follow a well established routine surrounded by physical exercises, which provides the peculiarities in CP when compared to the general population.

Thus the main objective of this study was to compare the body composition data obtained by the military through the body mass index, skinfold measurement and bioelectrical impedance.

MATERIAL AND METHODS

This is a cross-sectional exploratory study in which 153 military members of the Brazilian Army took part, located in a military troop organization in the city of Curitiba, state of Paraná. Data collection was done in three days during the month of July 2010. For this, a digital scale, brand Wiso W801 with capacity of 150 kg, a fixed stadiometer brand WCS, a Cescorf scientific adipometer and it was used BF -900 equipment (Maltron, UK) with tetrapolar arrangement for BIA.

To calculate BMI or Quetelet index, was used the equation: body mass (kg) / height ² (m). Being adopted as normal those below 25kg / m² and overweight as a BMI ≥ 25kg / m.

The skinfolds used in this study were: triceps, subscapular, pectoral, midaxillary, abdomen, suprailliac and thigh. They have being collected three times by a single trained assessor for calculating the arithmetic average. For the estimation of body density of individuals, the equation proposed by Jackson & Pollock ⁽¹⁶⁾ was used and the percentage of fat appealed the equation of Siri ⁽¹⁷⁾. The classification of the percentage of fat was measured by adapting the given Pollock & Wilmore (18) Table: Excellent (< 10 %); Above Average (11 % to 13 %); Average (14 % to 16 %); Below Average (18 % to 20 %) and Poor (> 20 %).

The instructions proposed by Earthman et al. ⁽¹⁹⁾ were used for the Bioimpedance, which suggest to the assessed not to drink large amounts of water, alcohol, urinate 30 minutes before the test and not perform vigorous exercise in the last 24 hours prior to evaluation. Subjects were placed in supine position on a stretcher, removed its metal objects and then four electrodes were placed using the following guidelines: right foot, distal electrode at the base of the proximal and middle finger between the medial and lateral malleolus; right hand, distal electrode at the base of the middle finger and the proximal electrode coinciding with the styloid process.

For data analysis we used descriptive statistics for the first general characterization of the sample mean and standard deviation, secondly there is the abnormality of the sample by using the *Kolmogorov-Smirnov* test, following verification of the Spearman correlation, comparisons between groups was due to the use of the *Mann-Whitney* test, adopting $p < 0.05$ for all tests.

The study followed the ethical aspects recommended by Resolution No. 196/96 on research involving human subjects and the ethical principles contained in the Declaration of Helsinki (1964, revised in 1975, 1983, 1989, 1996 and 2000), and has approved its project by Protocol 091/09 of the Federal University of

Paraná Research Ethics Committee, and all study participants signed a consent form explaining the study objectives.

RESULTS

153 soldiers, men, with a mean age of 19.60 ± 1.88 years, have been assessed for weight, height and BMI, the mean values as standard deviation were 70.98 ± 9.55 kg, $1.74 \pm 0,06$ meters and 23.90 ± 2.76 kg/m², respectively. The percentage of fat obtained by compass and by bioelectrical impedance was respectively 12.78 ± 5.45 and 16.29 ± 4.02 (Table 1).

Table 1 - General characteristics of the sample according to the variables. Age (years) Weight (kg) Height (m), BMI (kg / m²), skinfolds (%) and bioimpedance (%)

Variables	N	BMI <25		BMI ≥ 25		General	
		Mean ± DP	n	Mean ± DP	n	Mean ± DP	
Age	113	19,38 ± 1,67	40	20,12 ± 2,26	153	19,60 ± 1,88	
Weight	113	67,66 ± 7,06	40	80,37 ± 9,49	153	70,98 ± 9,55	
Height	113	1,74 ± 0,05	40	1,74 ± 0,07	153	1,74 ± 0,06	
BMI	113	22,24 ± 2,01	40	26,48 ± 2,14	153	23,90 ± 2,76	
Skin folds *	113	11,09 ± 4,12	40	17,55 ± 5,93	153	12,78 ± 5,45	
Bioimpedance*	113	14,99 ± 3,24	40	19,95 ± 3,80	153	16,29 ± 4,02	

* This amount refers to the percentage of fat obtained by each method.

One can note an increase of age accompanied by an increase in BMI and increased amounts of fat percentage, but that age difference did not show statistically significant differences ($p = 0.161$) verified by the Mann-Whitney test.

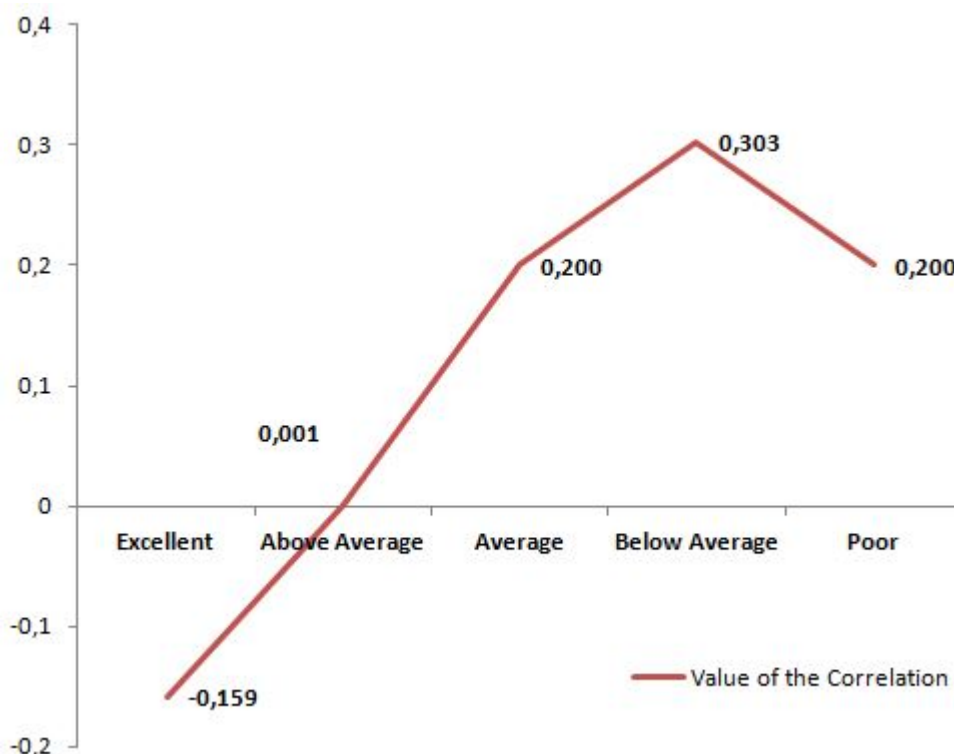
Table 2 shows the mean and standard deviation for each rating category fat percentage using the Adipometer and the values obtained with the use of electrical bioimpedance, analyzed into distinct groups.

Table 2 - General characterization of the sample according to the percentage of fat.

Classification	n	Skinfolds		Bioimpedance		<i>r</i>	<i>p</i>
		Mean ± DP	n	Mean ± DP			
Excellent	52	7,67 ± 1,30	3	9,15 ± 0,21	-0,159	0,259	
Above Average	52	11,63 ± 1,14	51	12,41 ± 1,01	0,001	0,997	
Average	16	15,60 ± 0,89	34	15,37 ± 0,80	0,200	0,457	
Below Average	19	18,61 ± 0,88	44	18,59 ± 1,24	0,303	0,207	
Poor	14	24,90 ± 2,49	21	23,38 ± 2,12	0,200	0,493	

Note that there is a disparity in the size of each sample for each category the percentage of fat. Although there was no statistically significant correlation between the strata, Figure 1 suggests that the use of bioimpedance is more indicated in subjects with percentage of fat between 18 and 20 percent.

Graph 1 - Correlation between methods for Skinfolts (SF) and electrical bioimpedance (BIA) for each classification of fat percentage.



On the other hand, when it modifies the way to stratification of groups ⁽¹⁾ for below the median ⁽²⁾ and above the median (14.14%), due to the increase of the N layers, correlations show much better in both layers.

Table 4 - Correlation between Skinfolts (SF) and electrical bioimpedance (BIA)

DC vs BIA	n	R
≤ 14,14% (DC)	106	0,442*
> 14,14% (DC)	47	0,750*
General	153	0,751*

* P <0.05

DISCUSSION

Oliveira e Anjos ⁽²⁰⁾ in a study with 52,523 military from 36 Brazilian Army Garrisons with an average age of 25.8 ± 6.6 years, found, using BMI, an average value of 24.2 ± 3.1 kg / m², despite the higher age group (19.60 ± 1.88 years), the military from this study showed similar values , with average BMI equal to 23.90 ± 2.76 kg / m², indicating a possible change in nutrition or physical habits. *Neves* ⁽²¹⁾ states that the relative risk of mortality associated with BMI has been presented with a graph of U or J shape, where less than 25kg / m² values comprise the lowest health risks. Another survey of 1,174 US military personnel with equal ages in this study found average values of $25.2 \pm$

3.9 kg / m² ⁽²²⁾, a result that puts, in general, this population as prone to risks from the excess fat.

Note that the group with higher BMI (BMI ≥ 25), also have a higher average age, and showed the highest values of % BF observed in both methods. *Vieikov*⁽²³⁾ suggests that advancing age contributes to increased body mass while experiencing a decrease in muscle mass and an increase in fat mass, a factor from negative changes in biological functions due to aging.

Nierdmann et al. ⁽²⁴⁾ state that the method of BMI in overweight and obese individuals are prone to underestimation, for the slender population with adequate weight the method overestimates the actual body composition, which contradicts the findings of the present study. *Oliveira and Anjos* ⁽²⁰⁾ point out that if you only use this index to detect health risks, it can provide high inaccuracy. Thus the widespread use of BMI for epidemiological studies, to be a simple and low operating costs ⁽²⁵⁾ technique can provide erroneous data on the characterization of a given population, the introduction of bias in the studies by not considering variables such as gender, bone structure, fat mass, lean mass⁽²⁶⁾.

Excess body fat is a chronic degenerative disease that is associated with high morbidity and mortality in adults. Correctly estimate the values of body composition, due to the necessity to identify and promote understanding of the health risks associated with low or high levels of total body fat as the health risks associated with excessive accumulation ⁽²⁷⁾. Thus instruments which measure with high precision and reproducibility are fundamental to the detection of problems related to body composition ⁽⁸⁾.

Rodrigues et al. ⁽²⁸⁾ have described a growing number of studies using the technique of bioelectrical impedance to assess body composition, however when comparing the techniques of bioelectrical impedance, skinfold with hydrostatic weighing (considered the reference method) the authors concluded that skinfolds correlate better with the hydrostatic method than the BIA. A similar result was found by *Lints, Karma and Kull*, ⁽²⁹⁾ when comparing BIA and SF with the results obtained by DEXA, again having the best correlation of SF with a gold standard method. *Neovius et al.* ⁽³⁰⁾ and *Sun et al.* ⁽³¹⁾ show a tendency to overestimate BFP with the bioimpedance versus DEXA with slender individuals and underestimated in overweight and obese individuals.

Swan and McConnell ⁽³²⁾ and *Rossi and Tirapegui* ⁽³³⁾ in their studies again confirm the differences between the methods set out above, where the first aimed to investigate the accuracy in five anthropometric equations and three BIA in women with different patterns of fat accumulation body (abdominal and lap), and second the assessment of body composition in athletes.

The disparity in the size of each sample for each category of the fat percentage measured by BIA and SF (Table 2), points out the difference in which the evaluator may find in the analysis of results, where the overestimation of BIA is

categorized. *Durenberg and Durenberg-Yap*⁽³⁴⁾ state that the accuracy of BIA depends among other factors, specific and validated equations for the population being evaluated. Equations not provided by the equipment used in this study, which may explain the disparity in results manufacturer.

For *Spearman* methods of SF and BIA, there was a strong correlation ($r = 0.751$), when sectioned in the group BFP higher and lower than the median, has respectively a correlation of $r = 0.750$ and $r = 0.442$.

The use of skinfold thickness is still the preferred method for assessing large groups with low cost, and the lack of more precise equipment, because it has, as mentioned, results with better correlations with other methods that are considered more accurate as DEXA and PH^(28 - 29). The BIA has advantages such as ease of use of the method and minimal chance of inter-and intra - examiner error that results in a useful method for population studies, representing great potential for research⁽³⁵⁾.

CONCLUSIONS

The comparison of the data of body composition by skinfold method, bioelectrical impedance and body mass index (BMI) in young adults showed correlated data.

The bioimpedance (BIA) is shown to be better utilized as a method of assessing body composition in population studies, being more appropriate its use in groups whose percentage of fat varied around 18% and 20 %, however the low correlation does not put this method as a sufficiently appropriate method, as well as the study was limited to using the skinfold method and not considered the gold standard (DEXA).

By comparing this method with BMI, bioimpedance is more precise because it allows estimation of lean body mass, and considers more factors in predicting body composition. The comparison with skinfold method showed that BIA tends to overestimate body fat percentage of thinner individuals, however no statistically significant correlations.

REFERENCES

- 1 Martínez-de-Haro V, Pareja-Galeano H, Álvarez-Barrio MJ, del Campo Vecino J, Yague CL, Muñoz-Blas J. Sistema gráfico para evaluar la actividad física en relación a la salud. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte* vol. 11(43): 608-618, 2010.
- 2 Organização Mundial Da Saúde. Consultation on Obesity, Obesity: preventing and managing the global epidemic. *WHO Technical Report Series*, Geneva, 2010.
- 3 Henríquez Olguín, C. Mortalidad atribuible a inactividad física en Santiago de Chile. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte* vol. 9 (34): 105-113, 2009.
- 4 Mazza A, Zamboni S, Tikhonoff V, Schiavon L, Pessina AC, Casiglia E. Body mass index and mortality in elderly men and women from general population. The experience of Cardiovascular Study in the Elderly. *Gerontology*, 2007, 53(1): 36-45.
- 5 Buscariolo FF, Catalani MC, Dias CGD, Navarro AM. Comparação entre os métodos de bioimpedância e antropometria para avaliação da gordura corporal em atletas do time de futebol feminino de Botucatu/SP. *Rev.Simbio-logias*, 2008, 1(1): 122-129.
- 6 Neves, EB, Pino, AV, Souza, MN. Comparison of two bioimpedance spectroscopy techniques in the assessment of body fluid volumes. In: 31th Annual International Conference of the IEEE Engineering in Medicine and Biology Society. *Proceedings of the 31th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*. Mineapolis, p.853-856, 2009.
- 7 Costa R. *Composição corporal: teoria e prática da avaliação*. Barueri: Manole, 2001.
- 8 Rezende F, Rosado L, Franceschini S, Rosado G. Revisão crítica dos métodos disponíveis para avaliar a composição corporal em grandes estudos populacionais e clínicos. *ALAN*, 2007, 57(4): 327-334.
- 9 American College Of Sports Medicine. *ACSM'S Health-related physical fitness assessment manual*, Rio de Janeiro: Guanabara Koogan, 2006.
- 10 Witt KA, Bush, EA. College athletes with an elevated body mass index often have a high upper arm muscle area, but not elevated triceps and subscapular skinfolds. *J Am Diet Assoc*, 2005, 105(4): 599-602.
- 11 Pitanga FJG. *Teste, Medidas e Avaliação Física em Educação Física e Esportes*. São Paulo: Phorte, 2008.
- 12 McArdle W, Katch FI, Katch VL. *Fisiologia do exercício: Energia, nutrição e desempenho humano*. 5ª ed. Guanabara Koogan: Barueri, SP, 2003
- 13 Lobo HÁ, Baxter YC, Kiss MAPDM, Carazzato JG, Gagliardi JFL, Perrout JL. Estudo comparativo de avaliação da composição corporal pelos métodos antropométrico, bioimpedanciometria e hidrodensitometria em atletas masculinos competitivos de judô. *Rev Bras Med Esport*, 1996, 2(1): 3-6.
- 14 Román MC, Torres SP, Bellido MC. Bases físicas del análisis de la impedancia bioeléctrica. *Vox Paediatr*. 1999, 7(2): 139-43.

- 15 Estado Maior do Exército. *Manual de treinamento físico militar* (C 20 20). Brasília: Egceef, 2002.
- 16 Jackson AS, Pollack ML. Practical assessment of body composition. *The physician and Sport medicine*, 1978, 13(1): 76-90.
- 17 Siri WE. Body composition from fluid spaces and density: analysis of method. In: Brozek, J, Henschel, A. Techniques for measuring body composition. *National Academy of Sciences*, 1961: 223-224,.
- 18 Pollock ML, Wilmore, JH. *Exercícios na saúde e na doença*. 2 ed. Rio de Janeiro: Medsi, 1993.
- 19 Cruz JRA, Armesillas MDC, Lucas AH, Riaza LM, Pascual CM, Manzanido JP et al. Protocolo de valoración de la composición corporal para el reconocimiento médico-deportivo. Documento de consenso del Grupo español de cineantropometría de la federación española de medicina del deporte. *Archivos de Medicina del Deporte*, 2009, 131: 166-179.
- 20 Oliveira EAM, Anjos LA. Medidas antropométricas segundo aptidão cardiorrespiratória em militares da ativa, Brasil. *Rev Saúde Pública*, 2008, 42(2): 217-23.
- 21 Neves EB. Prevalência de sobrepeso e obesidade em militares do exército brasileiro: associação com a hipertensão arterial, *Ciênc. saúde coletiva*, 2008, 13(5): 1661-8.
- 22 Rexrode KM, Carey VJ, Hennekens CH, Walters EE, Colditz GA, Stampfer MJ. et al. Abdominal adiposity and coronary heart disease in women. *JAMA*, 1998, 280(21): 1843-8.
- 23 Voeikov VL. Bio-physico-chemical aspects of aging and longevity. *Adv Gerontol*, 2002, 9(1): 54-66.
- 24 Niedhammer I, Bugel I, Bonenfant S, Goldberg M, Leclerc, A. Validity of self-reported weight and height in the French GAZEL cohort. *Int J Obes Relat Metab Disord*, 2000, 24(9): 1111-8.
- 25 Lin DC. Actual measurements of body weight and height are essential: most self-reported weights and heights are unreliable. *Nutr Today*, 2007, 42(6): 263-6.
- 26 Rothman KJ. BMI related errors in the measurement of obesity. *International Journal of Obesity*, 2008, 32(1): 56-59.
- 27 Petroski EL. *Antropometria: técnicas e padronizações*. Porto Alegre: Pallotti, 1999.
- 28 Rodrigues NM, Silva SC, Monteiro DW, Farinatti PTV. Estimativa da gordura corporal através de equipamentos de bioimpedância, dobras cutâneas e pesagem hidrostática. *Rev Bras Med Esporte*, 2001, 7(4): 125-131.
- 29 Lintsi M, Kaarma H, Kull I. Comparison of hand-to-hand bioimpedance and anthropometry equations versus dual-energy X-ray absorptiometry for the assessment of body fat percentage in 17–18-year-old conscripts. *Clin Physiol Funct Imaging*, 2004. 24(3): 85–90.
- 30 Sun G, French CR, Martin GR, Younghusband B, Green RC, XIE, YG, et al. Comparison of multifrequency bioelectrical impedance analysis with dualenergy X-ray absorptiometry for assessment of percentage body fat in a large, healthy population. *Am J Clin Nutr*, 2005, 81(1): 74-8.

- 31 Swan PD, Mcconnell KE. Anthropometry and bioelectrical impedance inconsistently predicts fatness in women with regional adiposity. *Med. Sci. Sports Exerc*, 1999, 31(7): 1068-1075.
- 32 Rossi L, Silva RC, Tirapegui J. Avaliação nutricional de atletas de karatê. *APEF*, 1999, 14(1): 40-49.
- 33 Deurenberg P, Deurenberg-Yap M. Validity of body composition methods across ethnic population groups. *Acta Diabetol*, 2003, 40(1): 246-9.
- 34 Cocetti M, Castilho SD, Barros Filho AA. Dobras cutâneas e bioimpedância elétrica perna-perna na avaliação da composição corporal de criança. *Rev de Nutrição*, 2009, 22(4): 527-66.

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