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Trabajo Original

Valoración nutricional

Use of different segmental multi-frequency bioelectrical impedance devices for analysis of body composition in young adults: comparison with bioelectrical spectroscopy

Uso de diferentes equipamientos de bioimpedancia eléctrica multifrecuencia para análisis de la composición corporal en adultos jóvenes: comparación con espectroscopia bioeléctrica

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Abstract

Introduction: recently there have been several new versions of equipment based on the principles of bioelectrical impedance (BIA). Therefore, it is important to know the agreement between data produced by different commercially available equipment.

Objective: to verify the agreement between fat-free mass (FFM), fat mass (FM), and body fat percentage (BF%) estimated using different segmental multi-frequency BIA (Tanita® MC-980U and InBody 770®) and whole-body spectral techniques (Xitron 4200).

Methods: the sample consisted of 117 adults of both sexes, aged between 18 and 28 years. Methodological procedures followed specific guidelines for each equipment model. Agreement was analyzed by the t-test for paired data, concordance correlation coefficient (CCC), and Bland-Altman plot.

Results: mean estimates of FFM, FM, and BF% produced by the Tanita® MC-980U and InBody 770® devices did not present statistical differences compared to the Xitron 4200® reference device. CCC values for FFM demonstrated magnitudes between 0.904 and 0.931, representing clinically acceptable strength of agreement, while for FM and BF% the strength of agreements was weak (< 0.90). Regarding the FFM, the bias showed underestimates of -0.98 kg to -1.69 kg, with limits of agreement between -7.32 kg and 3.94 kg. In the case of FM and BF%, overestimations were observed that reached values of 1.01 kg and 0.71%, with limits of agreement of -1.91 kg to 3.93 kg and -3.86% to 5.28%, respectively.

Conclusion: FFM, FM, and BF% estimated by the Tanita® MC-980U and InBody 770® devices were not individually comparable with estimates produced by the Xitron 4200® reference device; therefore, its replacement for diagnostic purposes and inter- or intra-subject comparisons is not recommended.

Key words:

Fat-free mass. Body fat. Body fat percentage. Measurement bias. Validity.

Resumen

Introducción: recientemente han surgido varias versiones de equipamiento que se basan en los principios de bioimpedancia eléctrica (BIA). Por lo tanto, es importante conocer la concordancia entre datos producidos por diferentes equipamientos disponibles comercialmente.

Objetivos: verificar la concordancia entre masa libre de grasa (MLG), masa grasa (MG) y porcentaje de grasa (%Grasa) estimadas por diferentes equipamientos de BIA por técnica segmentar de multifrecuencia (Tanita® MC-980U e InBody 770®) y espectral de cuerpo entero (Xitron 4200®).

Métodos: muestra constituida por 117 adultos de ambos sexos con edad entre 18 y 28 años. Los procedimientos metodológicos han seguido las directrices específicas de cada modelo de equipamiento. La concordancia se analizó mediante el test t para datos pareados, coeficiente de correlación de concordancia (CCC) y trazado Bland-Altman.

Resultados: las estimaciones medias de MLG, MG y %Grasa producidas por los equipamientos Tanita® MC-980U e InBody 770® no presentaron diferencias estadísticas en comparación con el equipamiento de referencia Xitron 4200®. Los valores de CCC para MLG presentaron magnitudes entre 0,904 y 0,931, lo que representa una fuerza de concordancia clínicamente aceptable, mientras que para MG y %Grasa la fuerza de concordancia fue débil (< 0,90). Con respecto al MLG, los sesgos apuntaron subestimaciones de -0,98 kg a -1,69 kg, con límites de concordancia entre -7,32 kg y 3,94 kg. En el caso de la MG y del %Grasa, se observaron sobreestimaciones que alcanzaron valores de 1,01 kg y 0,71%, con límites de concordancia de -1,91 kg a 3,93 kg y -3,86% a 5,28%, respectivamente.

Conclusión: la MLG, la MG y el %Grasa estimados por los equipamientos Tanita® MC-980U e InBody 770® no fueron comparables individualmente con estimaciones producidas por el equipamiento de referencia Xitron 4200®. Por lo tanto, no se aconseja su sustitución para efecto de diagnóstico y comparaciones inter o intraindividuos.

Palabras clave:

Masa libre de grasa. Grasa corporal. Porcentaje de grasa. Sesgo de la medida. Validez.

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INTRODUCTION

Through analysis of body composition it is possible to identify the main structural components of the human body, in particular the body weight fractions equivalent to fat mass (FM) and fat-free mass (FFM), used as important markers in the diagnosis of specific diseases (1,2), diet and exercise interventions (3,4), and performance improvement in athletes (5,6). As a result, there has been increasing interest from researchers and professionals from different areas in monitoring body composition, which has favored the development of new techniques and equipment that can offer greater validity of the estimates of its components (7). However, the results given by the different techniques available for analysis of body composition present variations depending on the biophysical assumptions that guide them and the requirements for conditions of use (8). In this context, it is important to know the limitations and potentialities of each technique as well as the validation criteria so that the estimates can be interpreted correctly.

Laboratory techniques, including dual-energy x-ray absorptiometry, computed tomography, magnetic resonance imaging, underwater weighing, and air displacement plethysmography, among others, provide very accurate estimates, thus representing the first choice to gather information about body composition. However, frequently, due to the high cost of the equipment, the requirement for complex installations, the methodological sophistication, the need for a technician specifically qualified to apply the procedures, and the difficulty in involving individuals in the measurement protocols, their use in the clinical environment has been limited (9). Thus, the simplicity and safety of procedures, portability of the equipment used, and relative ease of interpretation of the data have established bioelectrical impedance (BIA) as one of the techniques with greater applicability, encouraging an increasing number of professionals to use these methods (10,11). Several validation studies have been conducted with BIA procedures, and good correlations were found with reference techniques (12-17).

The BIA technique was originally described in the 1960s; however, it was not until 1980 that it became widely known (18). The procedures are based on the different levels of electrical conductivity of biological tissues exposed to an electric current. From data on the impedance, function dependent on the resistance presented by the tissues themselves, and the reactance or opposition caused by the insulation capacity to the conduction of the electric current presented by cell membranes and nonionic elements, the total, intra, and extracellular water quantities are estimated by specific formulas. Subsequently, through derivations using supposed fractions of body hydration, the proportions of FFM, FM, and body fat percentage (BF%) are calculated (19).

Recently, there have been several new versions of equipment based on the principles of BIA, broadly classified into two categories: mono-frequency and multi-frequency. Mono-frequency devices are more limited in their ability to distinguish water distribution in intra- and extracellular compartments, which weakens the validity indicators for FFM and FM estimates (10). Therefore, preference should be given to the use of multi-frequency equipment (11). The traditional characteristic of multi-frequency equipment involves spectral frequencies up to 1,300 kHz, denominated BIA spectroscopy. However, other derivations of multi-frequency equipment provide impedance data generated by a specific set of frequencies, including from the lowest to progressively higher frequencies, typically 5, 50, 250, 500, and 1,000 kHz (11,18). Thus, due to the need to establish comparisons between both configurations, it is important to know the agreement between data produced by different commercially available equipment.

The objective of the present study was to verify the agreement between FFM, FM, and BF% estimated by different BIA devices involving segmental multi-frequency (Tanita® MC-980U and InBody 770®) and whole-body spectral techniques (Xitron 4200®).

METHODS

EXPERIMENTAL APPROACH TO THE PROBLEM

Participants completed a single visit to the laboratory for this study. Subjects had body composition measured with BIA spectroscopy and two segmental multi-frequency BIA devices. The body composition indicators, including FFM, FM, and BF%, were estimated through formulas and algorithms contained in the software developed by the manufacturers themselves of each device.

SUBJECTS

To carry out the study, students were selected from the courses of nutrition and physical education of a Brazilian university. The intervention protocols were approved by the Research Ethics Committee of the institution. The inclusion of university students in the study was based on their desire to participate. To this end, all university students who attended both courses in the 2017 academic year were contacted and informed about the nature and objectives of the study and invited to participate. From a total of 298 undergraduates, 117 (66 women and 51 men) agreed to participate in the study, confirming by signing the free and informed consent. The participants were aged between 18 and 28 years (women: 22.4 ± 3.1 years; men: 23.3 ± 3.4 years).

PROCEDURES

The participants underwent the measurement protocols for the three devices in a single section, in a random sequence, between 7:00 and 9:00 in the morning and in a room with a controlled ambient temperature of approximately 23 °C. Initially, measurements of body weight and height were performed according to conventional methodology and the body mass index (BMI) was calculated, the ratio between body weight in kilograms and the square of the height in meters (20).

The methodological procedures for the BIA measurements followed the specific guidelines for the configuration of each device; however, the following were established as standard: a) not having used diuretic medications in the previous seven days; b) to have been fasting for at least four hours; c) not having ingested alcohol or caffeinated beverages in the previous 48 hours; d) having abstained from moderate-intense physical activity in the previous 24 hours; e) urinating at least 30 minutes prior to the measurement; f) wearing swimming trunks or swimsuits; g) being barefoot; h) not wearing watches, earrings, rings, bracelets, or any other metal accessory; and i) remaining for at least 8-10 minutes in absolute rest in the position required by the device (supine or orthostatic) before performing the measurement, in order to minimize any bias as a result of acute changes in the distribution of body fluids (10,11,15,18,19). Data collection was postponed for any women who noticed the presence of menstrual flow. In addition to these precautions, the calibration characteristics of each device were observed.

In the case of spectral BIA, Xitron Hydra 4200® (XitronTechnologies, San Diego, CA, USA) equipment was used. This equipment model employs 256 frequencies between 4 and 1,024 kHz and determines internally the quantities of body water (total, intra, and extracellular) using mathematical modeling based on the Cole-Cole plot and the Hanai mixing theory (21). To perform the measurements the participants were placed supine on a stretcher isolated from electric conductors, their arms discreetly removed from the trunk and their legs abducted and separated by about 45°. After cleansing the skin with tissue dampened in alcohol solution, the two emitting electrodes were attached distally to the dorsal surface of the right hand and foot, in the plane of the head of the third metacarpal and third metatarsal, respectively. In turn, the receptor electrodes were placed proximally also on the right hand and foot, the first on the wrist, in an imaginary plane of union of the two styloid apophyses, and the second on the dorsal region of the tibiotarsal joint, on an imaginary line of the salient part of the two malleoli (15). Disposable Ag/AgCl electrodes were used with adhesive and conductive gel with a contact area of 4 cm^2.

For the segmental multi-frequency technique, Tanita MC-980U® (Tanita Corporation, Inc, Tokyo, Japan) and InBody 770® (Biospace, Los Angeles, CA, USA) devices were used. Both devices feature a tetra-polar tactile electrode system with eight contact points, two on each hand and foot, and perform impedance measurements at six different frequencies (1, 5, 50, 250, 500, and 1,000 kHz) for each segment (right arm, left arm, trunk, right leg and left leg). For data collection, after cleansing the skin of the soles of the feet and palms of the hands with tissue dampened in alcohol solution, the participants positioned themselves on the tactile electrodes for the feet embedded in the platform of the respective equipment. They were instructed to remain in the orthostatic position and to hold the equipment loops by lateral abduction of the arms at approximately 20° and flexion of the scapulohumeral joint at around 30°, providing contact with the eight points of the tactile electrodes: two on each foot (metatarsals and calcaneus) and two on each hand (metacarpals of the 2nd-5th fingers and phalange of the thumb). Prior to performing the measurement, it was verified that the legs and thighs and arms and trunk were not in contact (13).

Prior to the beginning the measurement procedures, information about the participant, including sex, age, and height were recorded on the display of the three devices. Activating the equipment causes an electric current to travel through the participant's body, estimating a series of body composition indicators, including FFM, FM, and BF%, provided immediately through formulas and algorithms contained in the software developed by the manufacturers themselves. The procedures were replicated consecutively for each device and the average value of the indicators adopted as the representative values for the device.

STATISTICAL ANALYSIS

All data were analyzed using SPSS (version 24, IBM, Armonk, NY). Data were initially compared to the normal curve using the Kolmogorov-Smirnov distribution test. Considering that the data presented normal frequency distribution, the resources of parametric statistics were used. To characterize the sample, the descriptive statistics procedures (mean ± standard deviation) were used and, subsequently, the Student's t-test to identify any differences between the sexes. Agreement between the FFM, FM, and BF% values provided by Tanita® MC-980U, InBody 770®, and Xitron 4200® were analyzed using three statistical procedures:

1. Student's t-test for paired data.
2. Concordance correlation coefficient (CCC) proposed by Lin (22), which allows measurement of how much the pairs of measures produced by the equipment fit the identity line, established at 45° from the origin line. CCC values ≥ 0.90 were considered as clinically acceptable and CCC values < 0.90 were considered as weak (23).
3. Bland-Altman scatter plot, where the bias is represented by the mean difference accompanied by the standard deviation of the differences. In this case, the agreement limits of 95% were calculated by means of the mean difference ± 1.96 standard deviation of the differences between the devices (24,25).

RESULTS

Statistical information regarding the analyzed anthropometric variables is provided in table I. The participants of the study were aged between 18 and 28 years and, when comparing the mean values observed in both sexes, the differences found were not statistically indicated. However, mean values for body weight ($t = 13.327$, $p < 0.001$), height ($t = 17.728$; $p < 0.001$), and BMI ($t = 6.418$; $p < 0.001$) were significantly higher in men.

Statistical indicators regarding the degree of agreement of the measurements of FFM, FM, and BF% estimated by the Tanita® MC-980U, InBody 770®, and Xitron 4200® are shown in table II. In both sexes, the mean estimates of FFM, FM, and BF% produced by the Tanita® MC-980U and InBody 770® did not present statistical differences in comparison with the Xitron 4200® reference device. Values equivalent to the CCC for FFM estimated by the Tanita® MC-980U and InBody 770® devices presented magnitudes between 0.904 and 0.931, which represents a clinically

Table I. Mean, standard deviation and t-test values of anthropometric variables of the university students analyzed in the study

	Women (n = 66)	Men (n = 51)	t-test
Body weight (kg)	59.68 ± 8.05	75.35 ± 9.58	13.327 (p < 0.001)
Height (cm)	166.07 ± 5.69	177.62 ± 7.02	17.728 (p < 0.001)
BMI (kg/m²)	21.74 ± 3.65	23.96 ± 3.94	6.418 (p < 0.001)

BMI: body mass index.

Table II. Statistical indicators regarding the degree of agreement between fat free mass (FFM), fat mass (FM) and body fat percentage (BF%) estimated by the devices Xitron 4200®, Tanita® MC-980U and InBody 770®

	Mean ± standard-deviation	t-test	CCC*	Bias†	95% limit of agreement‡
Women (n = 66)					
FFM – *Xitron 4200®*	44.94 ± 5.76				
FFM – *Tanita® MC-980U*	43.05 ± 6.18	1.818 (p = 0.071)	0.904	-1.69 ± 2.87	-7.32 to 3.94
FFM – *InBody 770®*	43.68 ± 5.92	1.239 (p = 0.218)	0.921	-1.43 ± 2.55	-6.43 to 3.57
FM – *Xitron 4200®*	15.32 ± 2.47				
FM – *Tanita® MC-980U*	16.71 ± 3.13	2.432 (p = 0.064)	0.764	0.98 ± 1.74	-2.43 to 4.39
FM – *InBody 770®*	15.96 ± 2.75	1.407 (p = 0.162)	0.849	0.80 ± 1.62	-2.38 to 3.98
BF% – *Xitron 4200®*	25.53 ± 4.61				
BF% – *Tanita® MC-980U*	28.06 ± 5.28	2.553 (p = 0.059)	0.793	0.71 ± 2.33	-3.86 to 5.28
BF% – *InBody 770®*	26.78 ± 4.96	1.504 (p = 0.136)	0.875	0.43 ± 1.97	-3.43 to 4.29
Men (n = 51)					
FFM – *Xitron 4200®*	62.38 ± 7.82				
FFM – *Tanita® MC-980U*	61.19 ± 8.99	0.713 (p = 0.477)	0.914	-1.51 ± 2.56	-6.53 to 3.51
FFM – *InBody 770®*	61.94 ± 8.16	0.278 (p = 0.782)	0.931	-0.98 ± 2.04	-4.98 to 3.02
FM – *Xitron 4200®*	11.16 ± 1.96				
FM – *Tanita® MC-980U*	12.38 ± 2.34	2.654 (p = 0.061)	0.786	1.01 ± 1.49	-1.91 to 3.93
FM – *InBody 770®*	11.55 ± 2.17	0.952 (p = 0.343)	0.868	0.23 ± 1.10	-1.93 to 2.39
BF% – *Xitron 4200®*	15.23 ± 3.57				
BF% – *Tanita® MC-980U*	16.84 ± 4.15	2.100 (p = 0.069)	0.807	0.60 ± 1.73	-2.79 to 3.99
BF% – *InBody 770®*	15.67 ± 3.71	0.610 (p = 0.541)	0.882	0.33 ± 1.36	-2.34 to 3.00

**Concordance correlation coefficient. †Mean difference accompanied by the standard deviation of the differences. ‡Mean difference ± 1.96 standard deviation of the differences.*

acceptable strength of agreement, while for FM and BF% the strength of agreement was weak (< 0.90).

Regarding FFM, the biases point to underestimates varying from -0.98 ± 2.04 kg, with agreement limits between -4.98 kg and 3.02 kg (InBody 770® *versus* Xitron 4200® in men), and -1.69 ± 2.87 kg, with limits of agreement between -7.32 kg and 3.94 kg (Tanita® MC-980U *versus* Xitron 4200® in women). In the case of FM and BF%, overestimations are observed, reaching values of 1.01 ± 1.49 kg and 0.71 ± 2.33%, with agreement limits of -1.91 kg to 3.93 kg and -3.86% to 5.28% (Tanita® MC-980U *versus* Xitron 4200® in women), respectively.

Specific analysis of each device reveals that estimates of FFM, FM, and BF% produced by the InBody 770® tend to agree more closely with the estimates produced by the Xitron 4200®. In the comparison between the devices Tanita® MC-980U and Xitron 4200®, although relatively low mean differences are found, excessively high agreement limits are identified. When stratifying by sex, it is observed that men tend to present greater agreement between FFM, FM, and BF% estimated by the devices Tanita® MC-980U, InBody 770®, and Xitron 4200®.

Figure 1 shows the dispersion diagrams with a plot of the mean differences (abscissa) and individual differences between the BF% estimated by the considered device (ordinate). The graphical layout of individual data present different trends according to sex and device configuration. The women presented a positive association between the bias dimensions and the amounts of BF%, indicating that the BF% produced by the devices Tanita® MC-980U and InBody 770® is equally underestimated in smaller measures and overestimated in larger measures compared to the BF% produced by the Xitron 4200®. The differences are greatly

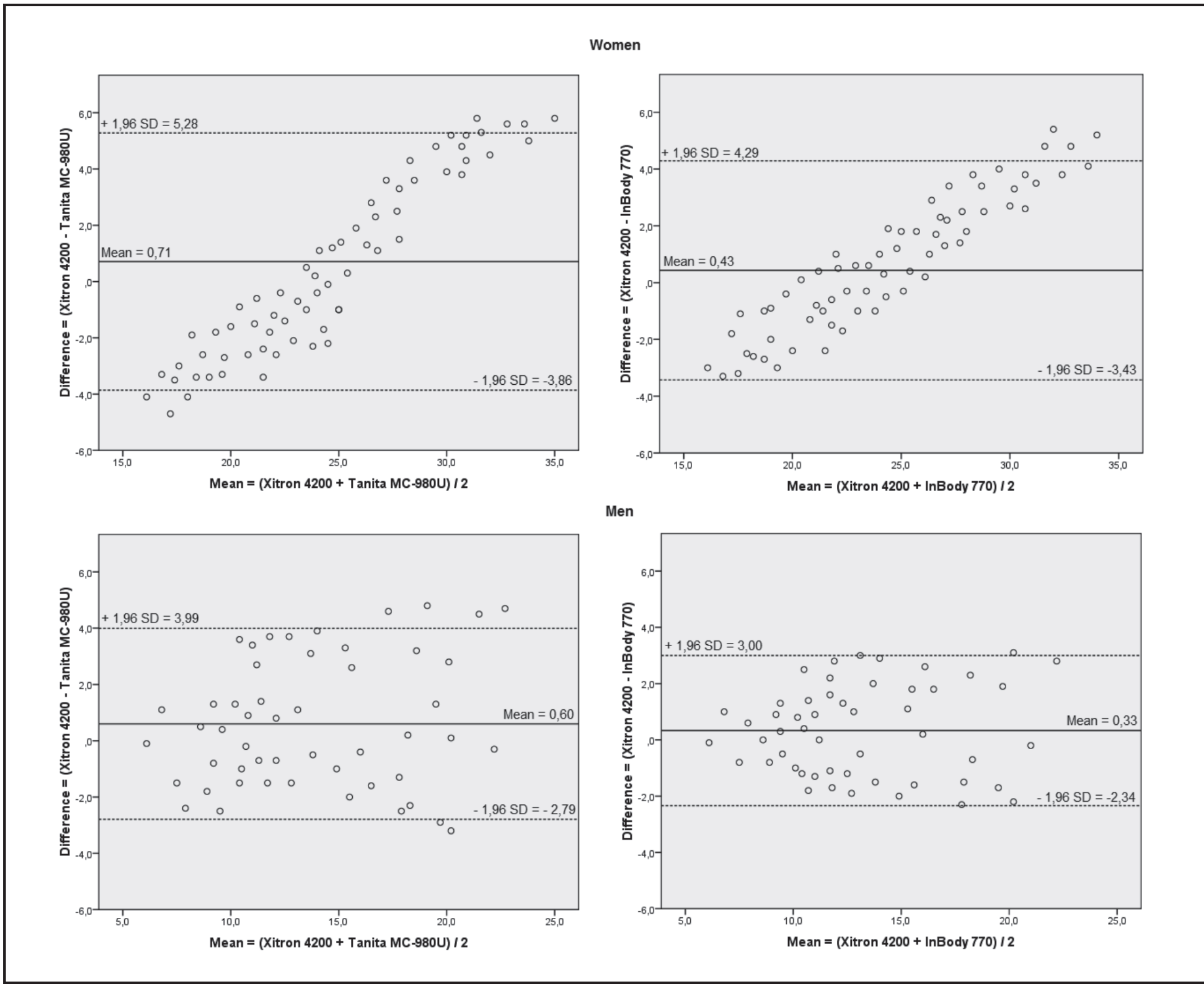

Figure 1.

Bland-Altman plot for the limits of agreement between amounts of body fat percentage (BF%) estimated by the devices Tanita® MC-980U, InBody 770® and Xitron 4200®. The solid line represents the mean difference between the estimates produced by the Tanita® MC-980U and InBody 770® in comparison with the Xitron 4200® reference device. The dashed lines represent ± 1.96 standard deviation of the differences.

diminished as the BF% approaches intermediate measures. On the other hand, in men, the comparisons between the individual measures of BF% estimated by the Tanita® MC-980U, InBody 770®, and Xitron 4200® suggest differences of smaller magnitude and similar behavior throughout the continuum of measurements.

DISCUSSION

The present study verified the agreement with which two segmental configuration multi-frequency devices (Tanita® MC-980U and InBody 770®) can estimate FFM, FM, and BF% values using as a reference a whole-body spectral configuration device (Xitron 4200®) in a sample of young Brazilian adults. The main finding pointed to a fragile agreement between the devices, and in the same participants, at the same time, and under the same conditions, Tanita® MC-980U and InBody 770® produced systematically overestimated individual measurements of FM and BF% compared to the Xitron 4200® and, in turn, underestimated FFM measures.

The use of the Bland-Altman procedure was fundamental for data analysis since, despite the lack of statistical differences between the mean FFM, FM, and BF% measurements produced by the Tanita® MC-980U and InBody 770® devices compared to the Xitron 4200® reference device, and the low magnitudes of the average biases, the limits of agreement of the individual measurements were extremely broad. The CCC values < 0.90 reinforced the fragility of agreement between the devices. In this regard, it should be pointed out that, in women, the degree of agreement was affected by the size of the adopted measures of FFM, FM, and BF%, which prevents the proposition of simple correction factors for adjustment in eventual comparisons between data produced by the devices.

Thus, the similarities between the mean measurements and the low magnitudes of the average biases suggest that if the purpose is to identify FFM, FM, or BF% in large-scale population surveys, then the use of the Tanita® MC-980U and InBody 770® may be an efficient alternative to replace or carry out comparisons with measures produced by the Xitron 4200® when it is not available or its procedures are not recommended for the specific situation. However, due to the broader limits of agreement, the Tanita® MC-980U and InBody 770® should be used with extreme caution in monitoring changes in individual body composition in the clinical setting.

Investigations with the purpose of identifying agreements between different configurations of BIA equipment under identical measurement conditions are common, be it in young, adult, and elderly populations. However, there has been a predominance of studies that seek to compare devices of tetra-polar *versus* bipolar configuration (26,27), multi-frequency *versus* mono-frequency (28), or compared with some reference method (12,16). To our knowledge, no previous studies have been conducted with the purpose of directly comparing spectral configurations of whole body and segmental multi-frequency equipment.

Immediately, it can be hypothesized that the observed discrepancies could be partially explained by methodological factors involving the orthostatic or supine position to perform the procedures and the arrangement of the electrodes emitting and receiving electric current. An orthostatic posture results in displacement of more fluid to the extremities, altering the volume and cross-sectional area and inducing changes in muscle hydration. Larger variations are identified in the proportion of extracellular fluids, as this compartment is more dependent on gravitational displacements (29). Experimental studies have shown that when posture changes from an orthostatic position to a supine position, extracellular water decreases significantly in the limbs (arms and legs); however, increases in the trunk region, causing, therefore, significant changes in the estimates of FFM, FM, and BF% (30).

Another decisive factor that may contribute to the divergences observed is the difference related to the emitting and receiving electrodes (type, quantity, and placement) used by the whole body spectral and segmental multi-frequency equipment. The Xitron 4200® reference device uses a tetra-polar disposable electrode system with adhesive and conductive gel fixed at four anatomical points, while the Tanita® MC-980U and InBody 770® devices, despite using a tetra-polar electrode system, are tactile and in contact with the body at eight anatomical points. Previous studies have shown that different electrode characteristics can significantly impact impedance measurements due to observed fluctuations in the distribution of the electric field (31).

Although spectral BIA, using the Xitron 4200®, was used as the reference configuration for comparison with segmental BIA using the alternative devices Tanita® MC-980U and InBody 770®, this configuration should not be considered as a gold standard for estimates of FFM, FM, and BF%. In this case, multi-compartmental analysis models, especially those involving four compartments, are the most indicated reference methods, since they do not assume theoretical assumptions and allow control of inter-individual variability of the various molecular components of FFM. However, studies of multi-compartmental models have pointed out that spectral BIA is a valid and convenient technique for establishing estimates of FFM, FM, and BF% (32,33), supporting its use as a reference configuration.

Although there are some uncertainties and controversies over their use, BIA procedures present numerous advantages for use in the clinical setting (2,10). However, concern regarding the configuration of the equipment and validity of the algorithms and formulas used by the manufacturer to estimate the total, intra, and extracellular water quantities is fundamental for the quality of the measurements of FFM, FM, and % Fat. Therefore, an important aspect to be highlighted is the fact that the FFM, FM, and BF% measurements in the present study were recorded based on information made available specifically by each of the three devices according to algorithms and formulas defined by their own manufacturers, which is the usual situation in the clinical environment. In this case, another possible contributing factor to the divergences found between the Tanita® MC-980U and InBody 770® compared to the Xitron 4200® reference device may be related to the differences in algorithms and formulas used by the manufacturers of the three devices for the estimations of FFM, FM, and BF%.

Even though a weak agreement was found between FFM, FM, and BF% measurements produced by spectral whole-body BIA (Xitron 4200®) and segmental multi-frequency BIA (Tanita® MC-980U and InBody 770®), it should be noted that the use of spectral whole-body BIA requires the placement of electrodes with adhesive and conductive gel at specific anatomical points, which increases the susceptibility of error, and the evaluated individual should be in a supine position. Therefore, in principle, the use of the segmental multi-frequency technique may be more convenient due to the use of tactile electrodes coupled to the equipment itself, which minimizes the possibility of error related to the placement of electrodes with adhesive and conductive gel, and the evaluated individual is maintained in an orthostatic position, making it more feasible from a practical point of view. In addition, due to the lack of stretchers, the measurement procedures using segmental multi-frequency devices require less space in the clinical environment (14).

Although the results obtained in the present study are innovative based on the lack of previous research on the degree of agreement of these devices in the estimates of FFM, FM, and BF% in adults, some limitations should be considered. The spectral device Xitron 4200® was used as a reference for comparison with the other two devices. Although the Xitron 4200® presents high reproducibility of measurement and satisfactory validity for estimates of total, intra, and extracellular water in comparison with the deuterium dilution method (34,35), it is recognized that some discrepancies between the measures may be due to possible errors of estimates made by this device. Furthermore, other investigations similar to the present study used the Xitron 4200® as a reference for comparisons with other models of BIA equipment (36). Another limitation is the fact that the selected sample consists of a homogeneous group of apparently healthy young adults, with a relatively small proportion of participants with low or obese body weight. Therefore, the results are comparable only to individuals with similar characteristics and should not be generalized to other segments of the population or to individuals with any type of morbidity that affects nutritional status or hydration. For this, further investigations are required, including individuals with extreme body weight and of different age groups and ethnic backgrounds. In addition, the degree of agreement was verified in a cross-sectional observational study, and it is therefore advisable to extend the study to a longitudinal design.

CONCLUSION

The purpose of the present study was to provide evidence to support the use of segmental multi-frequency BIA equipment for analysis of body composition indicators in place of spectral BIA equipment. At times, it is useful to replace the use of spectral BIA equipment in the clinical environment as its procedures require the use of a stretcher and the placement of electrodes with conductive gel. However, based on the observed degrees of agreement, it can be concluded that estimates of FFM, FM and BF% measurements produced by the Tanita® MC-980U and InBody 770® devices are not individually comparable with estimates produced by the Xitron 4200® reference equipment in young adults; therefore, its substitution is not recommended for diagnostic purposes and inter- or intra-subject comparisons.

However, considering the statistical similarity observed between the mean measures and the low magnitudes of the average biases, estimates of FFM, FM and BF% produced by the three devices may possibly be comparable in epidemiological studies. In addition, in view of the use of tactile electrodes and, thus, the possibility of reducing the pre-measure preparation time of the evaluated individuals, minimizing the chances of inter- and intra-investigator errors and avoiding the presence of specialized technicians to perform the procedures, the Tanita® MC-980U and InBody 770® could be more inviting for large-scale surveys.

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