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Original article

Comparison of predictive equations of lean mass in young and postmenopausal women

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SUMMARY

Background and aim: The lean mass (LM) is a predictor of functional capacity, quality of life, and mortality. In this way, the LM should be measured by reliable methods. However, it presents high cost and generally predictive equations are used in clinical practice, but little is known which is the best predictive equation of LM in women. The purpose of the present study was to verify which predictive equation of LM correctly estimates the LM in young and postmenopausal women.
Methods: Eighty-one women aged 19–81 years were evaluated. Body weight, height, waist circumference, and skin folds (bicipital, tricipital, subscapular and suprailiac) were measured. The LM was evaluated by DXA and also estimated using the predictive equations of Hume I, Hume II, Salamat, Kulkarni I, and Kulkarni II. Bland-Altman analysis was performed to evaluate the over/underestimation of the LM by predictive equations.
Results: The equations of Salamat, Kulkarni II, Hume I and Kulkarni I overestimated the LM by 0.0 (7.0; −6.9) kg; 2.3 (7.5; −3.0) kg; 5.1 (9.0; 0.4) kg; and 9.7 (16.3, 3.1) kg, respectively; whereas Hume II equation underestimated the LM by −16.9 (−11.5; −22.2) kg.
Conclusions: The equation that presented a better prediction of LM was Salamat. However, it should be used with caution in clinical practice since this equation showed elevated confidence intervals and limits of agreements, and can lead to significant errors for some individuals.

1. Introduction

The measurement of lean mass (LM) is important because it predicts functional capacity, quality of life, morbidity, and mortality [1,2]. Women differ physiologically from men in body composition, especially the postmenopausal women, due to hormonal changes that lead to body fat increase and lean mass reduction. Therefore, special attention to women should be considered [3,4].

In this way, the LM should be measured by reliable methods, such as magnetic resonance, computed tomography and dual-energy X-ray absorptiometry (DXA). However, these methods present high cost and trained professionals are needed [5]. Therefore, anthropometry is generally used in clinical practice due to be a harmless, non-invasive, portable and low-cost methodology [6]. Nevertheless, the reliability of anthropometric methodology depends on the site of measurement, training status of the professional that performed the measurements and/or the correct choice of the equation that estimate LM in specific populations [5,6]. Considering that alternative and isolated anthropometric measurement (for example, adductor pollicis muscle thickness) does not seem to predict LM correctly [7], predictive equations of LM using anthropometric parameters might be a good option in clinical practice to estimate LM properly, although this is not well known.

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To the best of our knowledge, there are only few equations created for LM estimation in general population [8–10] and no previous study evaluated which can be the best equation to use in clinical practice in women. Therefore, we aimed to compare predictive equations of LM with those values measured by DXA in free-living women.

2. Methods

2.1. Subjects

This was a cross-sectional study evaluating 81 women between 19 and 81 years old entering in an exercise protocol in the Federal University of Triangulo Mineiro (UFTM), in Uberaba, Minas Gerais, Brazil. This study was approved by the Research Ethics Committee of UFTM (protocol number 1.090.676) and all participants signed an informed consent. The study included 29 young and 52 postmenopausal women (at least one year since the end of menstruation, self-reported) who provided all necessary information and agreed to participate the study. Women who presented cancer, chronic obstructive pulmonary disease; muscle, kidney or heart disease; vascular problems, pregnant, and use of hormonal replacement were excluded.

2.2. Anthropometric assessment

Weight, height, waist circumference (WC), and skinfold thickness (biceps, triceps, subscapular, and supra iliac) were evaluated. The measurement of body mass was made by a balance previously calibrated (Líder® balance, Araçatuba, Brazil), with the capacity until 200 kg. Height was assessed by a portable stadiometer (Welmy®), fixed through the wall and the body mass index (BMI) was calculated by the assessment of body weight (in kilograms) over height squared (in centimeters). Waist circumference was assessed at the midpoint between the last rib and iliac crest and a non-elastic tape was used. A calibrated skinfold caliper (Lange®) was used to evaluate skinfold thickness. The skinfolds were measured three times and the average of the three measures was used. All measurements were made according to Lohman anthropometry protocol [11].

2.3. Body composition

Lean mass (LM) and body fat mass were evaluated by DXA, using a scanner (Lunar iDXA, GE Healthcare, USA) and quantified by software Encore 14.10. To standardize hydration volunteers were instructed to drink 2 L of water 24 h prior the test and the evaluation was made after 8–10 h fasting. The individuals also had to wear light clothes without metallic accessories, as previously described [12]. Predictive equations (Hume I [8], Hume II [8], Salamat [9], Kulkarni I [10], and Kulkarni II [10]) were used to estimated LM (Supplementary Table 1).

2.4. Statistical analysis

The results are described in mean and standard deviation. The *t*-independent test was used to compare the characteristics of young and postmenopausal women. Regression line with r^2 was performed to correlate the LM measured by DXA and estimated by equations. Bland-Altman [13] analysis was performed to evaluate the over/underestimation of the LM by predictive equations and the data were showed by mean, 95% limits of agreement, standard error and confidence intervals. The software STATISTICA 6.0 and MedCalc version 11.1 were used and $p < 0.05$ was adopted for statistical significance.

3. Results

The characteristics of the 81 women included in the study are described in Table 1. Postmenopausal women were older, presented higher body fat (%), BMI, weight, WC, and biceps skinfold than young women; but no differences were found for the other skinfold thickness and LM.

The Hume I, Kulkarni I and Kulkarmi II equations presented higher linear relationship with DXA ($R^2 = 0.791$, $R^2 = 0.760$, $R^2 = 0.785$, respectively), whereas Hume II and Salamat showed lower linear relationship ($R^2 = 0.655$ and $R^2 = 0.481$, respectively) (Fig. 1).

Evaluating all women together, the equations of Salamat, Kulkarni II, Hume I, and Kulkarni I overestimated the LM by 0.0 (7.0; −6.9) kg; 2.3 (7.5; −3.0) kg; 5.1 (9.0; 0.4) kg; and 9.7 (16.3, 3.1) kg, respectively. Additionally, Hume II equation underestimated the LM by −16.9 (−11.5 to −22.2) kg. Evaluating the results in percentage, Salamat, Kulkarni II, Hume I, and Kulkarni I equations overestimated LM by 0.1 (−19; 19.2) %; 5.9 (−7.4; 19.2) %; 13.1 (1.8; 24.4) %; 23.4 (10.4; 36.4) %; respectively, while Hume II equation underestimated LM by −60.2 (−84.1; −36.3) % (Table 2).

Evaluating young (Supplementary Fig. 1) and postmenopausal women (Supplementary Fig. 2) separated it was noted, in general, that the Bland Altman analysis results remained the same as that found for all women, whereas Salamat showed the best results in both groups. For young women, the equations of Kulkarni II, Hume I, and Kulkarni I overestimated the LM by 1.5 (6.0 to −3.0) kg, 6.0 (11.0–1.1) kg, 8.2 (13.2–3.2) kg, respectively. Salamat and Hume II underestimated the LM by −0.4 (5.5 to −6.3) kg, −18.4 (−14.4 to −22.4) kg, respectively. For postmenopausal women, the equations of Salamat, Kulkarni II, Hume I, and Kulkarni I overestimated the LM by 0.3 (7.8 to −7.2) kg, 2.7 (8.2 to −2.8) kg, 4.6 (8.9–0.3) kg, 10.5 (17.4–3.7) kg, respectively. Hume II underestimated the LM by −16 (−10.7 to −21.3) kg.

4. Discussion

The main finding of the present study was that Salamat [9] equation showed the best estimation of LM in women, independently of age, since this equation showed similar results for both young and postmenopausal women. However, although Salamat equation showed mean zero difference (evaluating mean values of all women), this equation should be used with caution in clinical practice since it presented high values of confidence intervals and limits of agreement; and can lead to important errors when applied to some individuals. With respect to other equations evaluated, we observed high variation in the prediction of the LM; therefore, the

Table 1
Demographic, anthropometric, and body composition characterization of young and postmenopausal women.

	All (n = 81)	Young (n = 29)	Postmenopausal (n = 52)	*p*-value
Age (years)	48.45 ± 19.60	24.05 ± 3.75	62.20 ± 8.43	<0.001
Weight (kg)	65.75 ± 13.50	60.20 ± 9.70	68.85 ± 14.35	0.004
Height (m)	1.56 ± 0.07	1.62 ± 0.06	1.53 ± 0.06	<0.001
BMI (kg/m^2)	26.90 ± 5.90	22.75 ± 3.15	29.20 ± 5.85	<0.001
WC (cm)	91.45 ± 14.35	80.25 ± 8.90	97.70 ± 13.00	<0.001
ST. Biceps (mm)	14.40 ± 5.40	11.40 ± 4.55	16.05 ± 5.15	<0.001
ST. Triceps (mm)	24.15 ± 6.45	22.60 ± 6.30	25.05 ± 6.45	0.107
ST. Subscapular (mm)	23.20 ± 7.30	22.50 ± 7.70	23.60 ± 7.15	0.517
ST. Supra Iliac (mm)	24.15 ± 8.15	21.95 ± 8.20	25.40 ± 7.90	0.067
LM (kg)	36.60 ± 4.50	36.45 ± 3.60	36.65 ± 5.10	0.844
BF (%)	39.48 ± 7.48	34.88 ± 5.83	42.05 ± 7.08	<0.001

BMI: Body Mass Index; WC: Waist circumference; ST: Skinfold thickness; LM: Lean mass; BF: Body fat.

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