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Bariatric patient's body composition: An option to BMI?

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SUMMARY

Background: Bariatric surgery is one of the best treatments for obesity. This indication includes an evaluation of body mass index (BMI) that does not consider the body composition of an individual.
Aim: To determine the body composition of bariatric surgery candidates.
Methods: Patients treated at a tertiary care centre for obesity were evaluated. Body composition was measured by bioelectrical impedance analysis (BIA). All measures of BIA and surgical indication were analysed.
Results: We evaluated 407 subjects, 87 (21.4%) men, with a mean age of 36 years. In men with indications for bariatric surgery, the mean ± SD body fat percentage (%BF) was 45.1 ± 5.39%, and the mean ± SD visceral fat area was 243.6 ± 33.79 cm^2. In women with indications for bariatric surgery, the mean ± SD %BF was 50.7 ± 3.3%, and the mean ± SD visceral fat area was 241.7 ± 24.77 cm^2.
Conclusion: This study showed different body compositions between men and women and parameters of %BF and visceral fat area evaluated by BIA.

1. Introduction

Obesity is a worldwide health problem associated with chronic diseases and elevated mortality [1,2]. Bariatric surgery is one of the best treatments for morbid obesity, leading to a reduction in mortality and marked improvement in related comorbidities, particularly type 2 diabetes mellitus (T2DM), dyslipidaemia and other metabolic syndrome (MSy) components [1,3].

Bariatric and metabolic surgery indications are still based on body mass index (BMI); however, BMI does not discriminate body composition, body fat percentage (%BF), and visceral fat [1], leading to an inaccurate estimation of body fat. Because of this misrepresentation through BMI, patients with a considerable amount of body fat are excluded from surgery.

Body composition, evaluated by bioelectrical impedance analysis (BIA), is based on the differences in electrical conductivity between body tissues; the procedure is simple to perform, reproductive, least expensive and considered accurate [4,5].

Obesity by BIA is considered with %BF greater than 25% and greater than 30% or 35% in men and women, respectively, depending on the analysis. If we use the same rates of obesity as when using BMI, then the %BF cutoffs are 29% and 41% fat mass in men and women, respectively [6,7]. Despite studies evaluating body composition by BIA comparing with BMI and correlating %BF and visceral fat with comorbidities, the use of BIA for obesity diagnosis and guide to treatment is not established [1,4,6–9].

Therefore, the aim of this study was to determine the body composition by BIA of patients with obesity who are candidates for surgery for obesity and weight-related disease.

2. Methods

This is a cross-sectional study involving obese patients from a tertiary university surgical obesity care centre attending public and private patients. Patients were invited to participate in the study

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after the routine initial evaluation. Those who agreed to participate in the study signed the informed consent form. Subjects with genetic disease, disabilities that hampered the examination, wheelchair users and patients with amputations were excluded from the study.

Because we treat every kind of obesity and weight-related disease, some participants did not have an indication for surgery in the beginning or end of evaluation. The patients without indication to surgery were our control.

Patients were evaluated for the presence of comorbidities such as hypertension and dyslipidaemia according to the *American Heart Association*, T2DM according to the *American Diabetes Association*, sleep apnoea according *American Thoracic Association* and MSy according to the *National Cholesterol Education Programme* (NCEP) [10].

The International Federation for the Surgery of Obesity and Metabolic Disorders was used to separate patients with and without indication to surgery. Only patients with BMI ≥35 with comorbidities associated with elevated weight or with BMI ≥40 are candidates for surgery. In the sample for this study, we did not use patients with contraindications to surgery, with spared then with or without surgery indication.

Height was measured. Weight was measured along with the other data obtained by way of BIA using the *InBody* 770 device (Tetrapolar 8-Point Tactile Electrodes with Thumb Electrodes, Direct Segmental Multi-Frequency Bioelectrical Impedance Analysis Method - DSM-BIA). The measurements were made with light clothes, with at least 2 h after the last meal, no menstrual cycle in the first visit or the last visit with the nutritionist.

Sample size was calculated considering 206.729.912 people and 17% of obese people (35.144.085) in our country, 5% error and 95% confidence interval. The sample size was 385 subjects.

Categorical data were presented as absolute and relative frequencies and continuous variables as the means and standard deviations. The symmetric distribution was assessed by a Kolmogorov–Smirnov test. Comparisons between means were performed using a t-test for independent samples. Categorical variables were compared with the Chi-square test. All analyses were performed with SPSS Statistics for Windows, version 17 (SPSS Inc., Chicago, IL, USA). Tests were bidirectional, and differences were considered significant if $p < 0.05$.

3. Results

From August 2015 to June 2016, 407 subjects were included, 320 (78.6%) were women, with a mean age of 36 ± 9 years, and there was no sex difference between age and surgery indication. When we compared comorbidities between sexes, only type 2 diabetes mellitus and dyslipidaemia were not significantly different (Table 1). All comorbidities were more frequent in surgical group, data not showed, probably because the comorbidities enter in surgical indication. The severity of comorbidities was not evaluate.

There was a significant difference in body composition measurements between men and women, except for visceral fat and waist/hip ratio (Table 2); for this reason, all the analyses were presented by sex.

The BMI, %BF, lean mass, BIA-measured waist and visceral fat were different between surgery indications for both sexes (Tables 3 and 4).

Table 1
Comorbidities frequencies by sex.

	Men, n (%)	Women, n (%)	P
Hypertension	48 (55.2)	132 (41.3)	0.003[a]
Type 2 diabetes mellitus	11 (12.6)	41 (12.8)	0.967
Dyslipidemia	48 (55.2)	187 (58.4)	0.625
Sleep apnea	31 (36.8)	68 (21.3)	0.003[a]
Metabolic syndrome	46 (52.9)	144 (45)	0.001[a]

Chi-square test.
[a] Statistically significant.

4. Discussion

This study presents body composition by sex and surgery indication. Our results showed a significant difference in BMI, %BF, lean mass, basal metabolic rate, BIA-measured waist and visceral fat between surgery indications for both sexes.

Although BMI continues to guide the treatment of the different degrees of obesity, it is clear that it does not determine disease severity, since it does not assess the amount of fat, much less its distribution, both of which are more related to risk of mortality and cardiovascular complications [1,11–14].

The aspect of greatest uncertainty is related to subjects with BMI <40 kg/m^2 or BMI <35 kg/m^2, or men with BMI of 40 kg/m^2, which may present a high proportion of muscle mass. It seems obvious that there is no doubt as to the indication of bariatric surgery for other patients, even based on BMI. This assurance occurs because, regardless of the distribution, the amount of fat has reached critical levels for health, and surgery has been demonstrated to reduce the rate of mortality and associated diseases in these cases [1,15–19]. In addition to the difference in %BF and its distribution in subjects with the same BMI, there are also differences between men and women and between different ethnic groups [1].

With a growing global epidemic of obesity and its complications, there is an increased need to assess, more accurately, the indications for bariatric surgery, a very effective but irreversible measure [1,14,20,21]. Faced with the fact that BMI may not be the best parameter, but in the absence of something better to replace it, several discussions and possibilities are raised. Body composition and other assessments related to metabolic risk, independent of BMI, such as T2DM, insulin resistance, visceral fat, non-alcoholic fatty liver disease and abdominal circumference, appear to be more suitable substitutes as criteria used to indicate surgical treatment [1,14,20,22].

Independent of evaluating disease and metabolic risks, which are fundamental [1,19,20], we also need more appropriate criteria for assessing the level of excessive fat that justifies surgical treatment. It is also essential to differentiate men and women, which are different in terms of body composition and to evaluate different ethnic groups. Our sample was composed primarily of Caucasians.

When considering body fat accumulation as a whole, without analysing its distribution (more related to metabolic risk), we believe that the most appropriate parameter to assess obesity should %BF. Considering our results, men with %BF of 45 and women with a %BF of 51 would be candidates for bariatric and metabolic surgery without any doubt, based on their BMI. These results are not different from those of another study that reported %BF in pre-operative patients of 45.3–51.2% in BMI between 44.3 and 61.4 kg/m^2, without differentiating gender [23]. However, these patients have 3rd degree obesity; therefore, these values of %BF neglect other subjects in the lower end that could also benefit from surgical intervention.

To overcome this discrepancy, we could use the standard deviation to estimate a lower limit to decide for surgery. Minus one SD leads to 39%BF in men and 47%BF in women, limits well above the recommended obesity cutoffs of 25%BF for men and 35%BF for women, or 29%BF for men 41%BF for women depending on the method of analysis [4,6]. Data from NHANES III showed the same risk for having MSy in both men and women with IMC = 35 kg/m^2, as well as in men with 35%BF and women with 43%BF [24]. Another study found that a 25.9%BF in men and 37.1%BF in women elevated

Table 2
Age, bioelectrical impedance analysis and anthropometrics parameters conform sex.

	Men (n = 87)	Women (n = 320)	P
Age (years), media (± SD)	37.40 (9.85)	36.86 (9.67)	0.642
BMI (kg/m^2), media ± SD	43.58 (6.97)	41.78 (5.53)	0.011[a]
Body fat percentage (%), media ± SD	44.59 (5.60)	50.45 (3.45)	<0.001[a]
Lean mass percentage (%), media ± SD	31.19 (4.56)	27.59 (1.95)	<0.001[a]
BIA[b] waist (cm), media ± SD	134.23 (10.91)	122.64 (9.88)	<0.001[a]
Visceral fat area (cm^2), media ± SD	239.77 (36.09)	239.39 (26.10)	0.927
Waist (cm), media ± SD	135.71 (13.72)	120.74 (11.36)	<0.001[a]
Waist:hip ratio, media ± SD	1.16 (1.01)	0.93 (0.08)	0.055

[a] Statistically significant.
[b] Bioelectrical impedance analysis.

Table 3
BMI and bioelectrical impedance measures in men conform bariatric surgery indication.

	Without indication	With indication	P
BMI (kg/m^2), media ± SD	34.18 (0.80)	44.28 (6.72)	<0.001*
Body fat percentage (%), media ± SD	37.66 (3.60)	45.10 (5.39)	0.001*
Lean mass percentage (%), media ± SD	35.25 (2.32)	30.89 (4.65)	0.026*
Waist (cm), media ± SD	119.61 (6.32)	135.31 (10.40)	<0.001*
Visceral fat area (cm^2), media ± SD	187.58 (25.11)	243.64 (33.79)	<0.001*

* Teste T para amostras independentes* P < 0.05.

Table 4
BMI and bioelectrical impedance measures in women conform bariatric surgery indication.

	Without indication	With indication	P
BMI (kg/m^2), media ± SD	34.63 (3.00)	42.25 (5.33)	<0.001*
Body fat percentage (%), media ± SD	46.71 (3.47)	50.70 (3.30)	<0.001*
Lean mass percentage (%), media ± SD	29.47 (2.14)	27.46 (1.87)	<0.001*
** waist (cm), media ± SD	110.20 (7.54)	123.46 (9.46)	<0.001*
Visceral fat area (cm^2), media ± SD	204.26 (19.79)	241.73 (24.77)	<0.001*

* Teste T para amostras independentes, P < 0.05.

their cardiovascular risk, determined by the presence of T2DM or MSy, [9]. Considering these studies, we propose to use the mean minus two SD, that is, 34%BF in men and 44%BF in women, to use as the lower cutoff to consider patients as candidates for surgical and metabolic surgery. In our sample, only 26 patients did not have surgical indications for traditional indications based on BMI. Based on %BF, all men excluded would be included in the surgical group, and 16 women (80%) would be included, independent of age.

Despite BIA overestimating body fat in patients with obesity, this occurs, principally in BMI above 40. The public over our greater interest is under this limit, and our BIA device already has formulas to adjust to the largest BMI.

Moreover, it is important to consider not only total fat but also body fat distribution, especially visceral fat, including area of visceral fat. Following the same reasoning of total body fat percentage, using the mean minus two standard deviations to consider the lower cutoff value to decide for surgery, we would find a visceral fat area of 176 cm^2 for men and 192 cm^2 for women.

This study has possible limitations. The first limitation is that we only included the Caucasian population, which precludes the generalization of our results to other ethnic populations. More studies, similar or with different populations, would contribute to confirming the necessary cutoff. Another limitation is that we only analysed BIA waist circumference. Considering this limitation, we compared this patient's traditional waist circumference with BIA assessment. Our analysis found a high agreement between both measurements (P < 0,001).

This study showed a significant difference in BMI, %BF, lean mass, basal metabolic rate, BIA-measured waist and visceral fat between surgery indications for both sexes.

Ethical statement and consent statement

The study was evaluated approved by the Institution's Ethics and Research Committee, under protocol number 48270515.3.10015336. All participants signed the informed consent form and authorized the use of their data in the study.

Author contributions

Letícia Biscaino Alves contributed to the conception of the work, the acquisition and interpretation of data.

Rita Mattiello contributed to the analysis and interpretation of the data.

Alexandra Todescatto contributed to the acquisition of data.

Edgar Sarria contributed to the review of the work.

Cláudio Corá Mottin contributed to the acquisition of the data and to the review of the work.

Alexandre Vontobel Padoin contributed to the conception and to the review of the work.

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Declaration of competing interest

The authors have no conflict of interest.

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