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Anthropometric and Body Composition Changes After Bariatric Surgery—The Effect of Sex, Age, and Type of Surgery

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Abstract: The rise in obesity and its associated health problems increases the need for therapeutic approaches such as bariatric surgery. Therefore, this study aims to explore the changes in the anthropometric and body composition characteristics of patients undergoing bariatric surgery. A retrospective longitudinal study was conducted in subjects $\geq$ 18 y who underwent bariatric surgery and attended one nutrition appointment before and after surgery. Information on their sex, age, weight, fat mass (kg and %), fat-free mass (kg and %), and skeletal muscle mass, obtained using bioelectrical impedance, and on their waist circumferences was collected. Their BMIs and skeletal muscle mass indexes were calculated. The differences in the anthropometric and body composition parameters between pre- and post-surgery were also calculated. The participants were grouped by sex, age groups (18–44 y and 45–69), and type of surgery (Roux-en-Y gastric bypass and gastric sleeve). The variables are presented as *n* (%) and as means (SDs) or medians (interquartile ranges). Student's *t*-test and the Mann–Whitney test were employed ($p < 0.05$). The sample consisted of 57 subjects (aged 18–69 years; 75% women). Between the pre- and post-surgical periods (63 (42) days), their weight (mean: 103.0 (SD: 16.3) kg vs. 91.2 (14.2) kg, $p < 0.001$); BMIs (37.9 (4.2) kg/m^2 vs. 33.6 (4.1) kg/m^2, $p < 0.001$); waist circumferences (116.2 (12.4) cm vs. 105.7 (12.3) cm, $p < 0.001$); % fat mass (45.5 (6.0) vs. 41.0 (8.0), $p < 0.001$); skeletal muscle mass (32.8 (7.4) kg vs. 30.3 (6.5) kg, $p < 0.001$); and skeletal muscle mass indexes (12.0 (1.8) kg/m^2 vs. 11.1 (1.7) kg/m^2, $p < 0.001$) decreased; meanwhile, their % fat-free mass increased (54.7 (6.0) vs. 59.0 (8.0), $p < 0.001$). Most of these changes occurred regardless of sex, age, or type of surgery. Shortly after bariatric surgery, patients show a better nutritional status and body composition.

Keywords: weight; body mass index; waist circumference; fat mass; fat-free mass; skeletal muscle mass; gastric sleeve; Roux-en-Y gastric bypass

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1. Introduction

Obesity is a chronic and serious disease of epidemic and global proportions, characterized by the abnormal or excessive accumulation of fat or adipose tissue in the body, which impairs health. A body mass index (BMI) between 25.00 and 29.99 kg/m^2 is considered pre-obese and a BMI over 30.00 kg/m^2 is considered obese. Obesity is deemed a relevant public health issue, as this disease is associated with the development and worsening of several other chronic diseases, such as diabetes mellitus, cardiovascular diseases, and some types of cancer [1].

According to the World Health Organization, in 2022, one in eight people in the world were living with obesity [2]. In Portugal, the 2nd National Dietary and Physical Activity Survey (2017) showed that 5.9 million Portuguese people, almost 6 in every 10 Portuguese people, had obesity or pre-obesity. The elderly are the most vulnerable group—8 in 10 are obese or pre-obese [3].

The current Portuguese guidelines follow the international standards and recommendations, and they state that the eligibility criteria for metabolic and bariatric surgery in adults are as follows [4]:

- A BMI $\geq$ 40 kg/m^2 with or without obesity-related health problems;
- A BMI $\geq$ 35 kg/m^2 with at least one health problem associated with obesity;
- Patients who have not responded satisfactorily to behavior modification treatment, whether associated with drug therapy or not, and who are motivated to lose weight and whose obesity-related health problems are expected to improve with surgery;
- Patients who have demonstrated adherence to the appointment scheduling in the preoperative phase.

Successful surgery implies the loss of at least 50% of excess body weight, which occurs up to 24 months post-surgery, followed by a period of weight maintenance or replacement of some of the lost weight [5]. Among adults with a BMI of 27 kg/m^2 to 43 kg/m^2 and type 2 diabetes, bariatric surgery plus medical therapy was more effective than medical therapy alone in decreasing weight and hyperglycemia at the 5-year follow-up [6]. Some studies, however, have demonstrated a high incidence of weight gain 5 years after surgery. The causes for this weight gain may be related to preoperative BMI, the presence of psychological illnesses, dilation of the gastric stoma, a sedentary lifestyle, and dietary patterns [7,8].

The most frequently used surgical procedures are gastric sleeves and Roux-en-Y gastric bypasses. Both types of surgery lead to a decrease in one's daily energy intake and consequent weight loss in the initial years after surgery [9].

Monitoring nutritional status in the bariatric surgery process is of utmost importance, as this allows for an adequate and personalized dietary progression in the different phases of the dietary intervention [1,5,7,8]. Nutritional assessments aim to include detailed anthropometric assessments, particularly using a tetrapolar bioelectrical impedance scale, from which the following parameters can be obtained: weight, skeletal muscle mass, fat mass, fat-free mass, total body water, percentage of body fat, basal metabolic rate, and segmented lean mass and fat mass [10]. In addition, our nutritional assessment also included other anthropometric measurements, such as stature and body circumferences, namely waist circumference. At the postoperative level, approximately one month after surgery, a re-assessment of nutritional status was carried out, which included the parameters mentioned in the preoperative phase [1,4,11–13].

Therefore, the present study aimed to assess the nutritional status of patients undergoing metabolic and bariatric surgery by exploring the changes in their anthropometric and body composition characteristics, thus improving dieticians' practice in their care for this population.

2. Materials and Methods

A retrospective longitudinal study was conducted on subjects who underwent bariatric surgery, between January 2016 and December 2021, at the Multidisciplinary Obesity Treatment Unit of Hospital-Escola da Fundação Fernando Pessoa (Teaching Hospital of the Fernando Pessoa Foundation).

Inclusion criteria were adults (≥18 years) who had attended at least two outpatient nutrition consultations, one pre-surgery and one post-surgery.

Socio-demographic information (age, sex, and profession), clinical information (diagnoses recorded in the medical file and presence of gastro-esophageal reflux) and information about the surgery (reason and type—gastric sleeve or Roux-en-Y gastric bypass), dates of pre- and post-surgery appointments, and date of surgery were collected from each participant's medical records. In addition, anthropometric data were obtained at the pre- and post-surgery appointments, with the patient in their underwear and without shoes.

Stature (m) was determined with a SECA® stadiometer (Hamburg, Germany, accurate to 0.1 cm), current weight (kg) with an InBody 230 (Gangnam-gu, Seoul, Republic of Korea, accurate to 0.1 kg), and waist circumference (cm) with a non-distensible tape measure from SECA® (Hamburg, Germany, accurate to 0.1 cm) [14].

Body composition was assessed using InBody 230 bioimpedance (Body Composition Analyzer) [15], including skeletal muscle mass (kg), fat mass (kg and %), and fat-free mass (kg and %). Skeletal muscle mass index was calculated as skeletal muscle mass (kg)/stature $(m)^2$.

Age was categorized into two groups: 18–44 years and 45–69 years. Body mass index was categorized as follows: 18.5–24.99 kg/m^2—normal weight, 25.00–29.99 kg/m^2—pre-obese, 30.00–34.99 kg/m^2—class I obese, 35.00–39.99 kg/m^2—class II obese, and ≥40.00 kg/m^2—class III obese [1,2]; waist circumference: low risk (women < 80 cm, men < 94 cm), high risk (women 80–88 cm, men 94–102 cm), and very high risk (women > 88 cm, men > 102 cm) [9]; fat mass was categorized as low; normal, and high [16]. The skeletal muscle mass index was also categorized as low, normal, and high [17].

This study was approved by the Health Ethics Committee of the Hospital-Escola da Fundação Fernando Pessoa (CES-HE-FFP) (reference nr. 86/2021 of 29 December 2021). All the data were collected as part of routine procedures carried out at the hospital by healthcare professionals and were, therefore, anonymized beforehand, while confidentiality was also guaranteed following the Declaration of Helsinki [18].

Statistical analysis was performed using IBM SPSS Statistics vs. 25.0® (IBM Corp., Armonk, NY, USA). Data were tested for normal distribution using the Kolmogorov–Smirnov test. Continuous variables are presented as mean (standard deviation) or median and interquartile range (IQR) and categorical variables as n (%). Differences in weight (kg), BMI (kg/m^2), waist circumference (cm), fat mass (kg and %), fat-free mass (kg and %), skeletal muscle mass (kg), and skeletal muscle mass index (kg/m^2) were calculated between pre- and post-surgical evaluations. Student's t-test for paired samples for continuous variables was used to compare anthropometric and body composition variables between the pre-and post-surgical periods, for the total sample, and also broken down by sex (women and men), age groups (18–44 years and 45–69 years), and type of surgery (Roux-en-Y gastric bypass and gastric sleeve). The Mann–Whitney test was used to compare the percentages of weight loss, BMI loss, waist circumference loss, fat mass loss, fat-free mass loss and skeletal muscle mass loss between sexes, age groups, and types of surgery. A $p < 0.05$ was considered for significance.

3. Results

Description of Results

A total of 57 patients were assessed, most of them being women (75%). Participants were aged between 18 and 69 years old, with most participants being aged from 45 to 49 years old (19.3%) and from 30 to 34 years old (17.5%). Among the participants, 37 (64.9%) were employed, 2 were retired, 3 were housewives, 1 was a student, and 1 was unemployed. Information on their profession was not available for 13 participants (22.8%). The median interval (IQR) between the pre-surgical evaluation and the surgery was approximately 26 (35) days and the median interval between the surgery and the post-surgical evaluation was approximately 31 (7) days. A median interval of 63 (42) days was calculated between the pre- and post-surgical evaluations.

Approximately 52.6% of patients presented obesity-related health problems or other diseases. The most prevalent pathological condition was gastroesophageal reflux (22.6%), followed by dyslipidemia (20.2%), hypertension (19%), renal lithiasis (11.9%), peripheral venous insufficiency (7.1%), hypothyroidism (6%), hepatic steatosis (4.8%), hyperuricemia (3.6%), fibromyalgia (2.4%), diabetes (1.2%), and the presence of human immunodeficiency virus (1.2%).

With regards to the type of surgery, 34 (59.6%) participants underwent gastric sleeve surgery and 23 (40.4%) underwent a Roux-en-Y gastric bypass. The reason for surgery in most cases was weight loss ($n = 41$, 71.9%) followed by improvement of general health status ($n = 16$, 28.1%).

Within this sample, the mean stature was 1.64 (0.08) m, with men being significantly taller than women: 1.74 (0.06) m versus 1.61 (0.06) m, $p < 0.001$. Statistically significant differences were observed between pre- and post-surgical evaluations ($p < 0.001$) for all anthropometric and body composition parameters. These differences were observed even when the results were broken down by sex, age group, and type of surgery ($p < 0.05$), with the exception of the fat-free mass (kg) parameter for the 45–69-year-old group (Table 1).

In the pre-surgery period, 11 (9.3%), 34 (59.6%), and 12 (21.1%) participants were class I, II, and III obese, respectively. In the post-surgery period, 2 (3.5%), 5 (8.8%), 31 (54.4%), 15 (26.3%), and 4 (7.0%) were in the categories of normal BMI, pre-obese, and class I, II, and III obese, respectively. A decrease from 21.1% to 7% was observed in the proportion of patients classified as class III obese, from pre-surgical to post-surgical evaluation. In the pre-surgery period, all participants ($n = 48$) were in the very-high-risk category for waist circumference, reflecting increased cardiometabolic risk. In the post-surgery period, four (8.3%) and one (2.1%) passed to the high-risk and low-risk category, respectively, improving their cardiometabolic risk.

From the pre-surgical to post-surgical period, a decrease in the total amount of fat mass, fat-free mass, and skeletal muscle mass was observed. However, although there was an increase in the proportion of fat-free mass relative to total body mass, this did not occur in the proportion of fat mass to total body mass (Table 1). All participants had high fat mass in both periods. Although there were losses of skeletal muscle mass from the pre-surgical to the post-surgical period, none of the patients had final skeletal muscle mass index values below the reference values, according to sex and age. In fact, in the pre-surgical period all men and all women were in the high category and, in the post-surgical period, only two men (14.3%) changed to the normal category and most participants, 96.5% of the study sample, exhibited high skeletal muscle mass index.

Table 1. Anthropometric * and body composition * characteristics of 57 adult patients submitted to bariatric surgery for the total sample and stratified by sex, by age groups, and by type of surgery.

				Sex						Age Groups						Type of Surgery					
				Women (n = 43)			Men (n = 14)			18–44 Years (n = 35)			45–69 Years (n = 22)			Roux-en-Y Gastric Bypass (n = 23)			Gastric Sleeve (n = 34)		
	Pre-Surgery	Post-Surgery	p **	Pre-Surgery	Post-Surgery	p **	Pre-Surgery	Post-Surgery	p **	Pre-Surgery	Post-Surgery	p **	Pre-Surgery	Post-Surgery	p **	Pre-Surgery	Post-Surgery	p **	Pre-Surgery	Post-Surgery	p **
Weight, kg	103.0 (16.3)	91.2 (14.2)	<0.001	98.2 (11.7)	88.3 (11.8)	<0.001	117.9 (19.8)	100.0 (17.4)	<0.001	107.9 (17.3)	95.6 (15.0)	<0.001	95.2 (11.1)	84.1 (9.4)	<0.001	104.8 (18.5)	91.5 (17.1)	<0.001	101.8 (14.9)	91.0 (12.1)	<0.001
BMI, kg/m^2	37.9 (4.2)	33.6 (4.1)	<0.001	37.6 (3.6)	33.7 (3.7)	<0.001	38.7 (5.7)	33.5 (5.2)	<0.001	38.1 (4.6)	33.8 (4.5)	<0.001	37.6 (3.4)	33.3 (3.4)	<0.001	39.0 (4.6)	33.6 (4.7)	<0.001	37.2 (3.7)	33.6 (3.7)	<0.001
Waist circumference [a], cm	116.2 (12.4)	105.7 (12.3)	<0.001	112.0 (10.4)	103.5 (11.3)	<0.001	125.8 (11.7)	112.7 (11.5)	<0.001	116.9 (14.9)	106.2 (14.5)	<0.001	115.3 (7.9)	105.0 (8.5)	<0.001	115.3 (13.0)	103.2 (15.6)	<0.001	116.9 (12.2)	107.5 (9.2)	<0.001
Fat mass [b], kg	46.0 (9.3)	37.8 (9.3)	<0.001	46.3 (7.7)	40.2 (8.8)	<0.001	45.0 (13.0)	34.2 (11.4)	<0.001	46.9 (10.7)	38.5 (10.2)	<0.001	44.6 (6.7)	36.7 (8.0)	<0.001	48.7 (9.0)	38.8 (10.0)	<0.001	44.0 (9.2)	37.1 (8.8)	<0.001
Fat mass [b], %	45.4 (6.0)	41.0 (8.0)	<0.001	48.2 (3.3)	43.6 (7.0)	<0.001	37.6 (4.7)	34.0 (6.0)	0.021	43.7 (6.3)	40.7 (7.8)	<0.001	47.8 (4.8)	41.4 (8.4)	<0.001	47.1 (4.2)	41.5 (7.8)	0.002	44.1 (6.8)	40.7 (8.2)	0.002
Fat-free mass [b], kg	58.0 (12.1)	54.0 (10.7)	<0.001	52.6 (7.9)	49.3 (7.2)	<0.001	72.9 (8.3)	66.3 (7.8)	<0.001	61.5 (12.3)	56.4 (11.1)	<0.001	53.0 (10.1)	50.4 (9.2)	0.063	56.8 (11.9)	53.6 (11.2)	0.013	58.9 (12.3)	54.3 (10.5)	<0.001
Fat-free mass [b], %	54.7 (6.0)	59.0 (8.0)	<0.001	51.8 (3.3)	56.4 (7.0)	<0.001	62.4 (4.7)	66.1 (6.0)	<0.001	56.3 (6.3)	59.3 (7.8)	0.005	52.2 (4.8)	58.6 (8.4)	0.001	52.9 (4.2)	58.5 (7.8)	0.002	55.9 (6.8)	59.3 (8.2)	0.002
Skeletal muscle mass [b], kg	32.8 (7.4)	30.3 (6.5)	<0.001	29.4 (5.0)	27.6 (4.7)	<0.001	41.9 (5.0)	37.7 (4.6)	<0.001	34.9 (7.6)	31.9 (6.7)	<0.001	29.7 (6.1)	27.9 (5.4)	0.012	32.0 (7.3)	29.6 (6.6)	<0.001	33.4 (7.6)	30.8 (6.4)	<0.001
Skeletal muscle mass index [b], kg/m^2	12.0 (1.8)	11.1 (1.7)	<0.001	11.3 (1.5)	10.6 (1.6)	<0.001	13.7 (1.2)	12.4 (1.2)	<0.001	12.2 (1.9)	11.2 (1.7)	<0.001	11.6 (1.6)	11.0 (1.6)	0.017	11.9 (1.8)	11.0 (1.8)	0.002	12.1 (1.8)	11.2 (1.6)	<0.001

* Values expressed as mean (SD); ** p values determined with Student t-test for paired samples. [a] n = 48. [b] n = 52.

Comparing both sexes, from the pre-surgical to post-surgical period, statistically significant differences were only found for the percentage of weight loss and the percentage of BMI loss (Table 2). Men were found to lose a higher percentage of weight and of BMI. Differences were not statistically significant according to age groups and, regarding the surgical method, Roux-en-Y gastric bypass led to a higher BMI loss compared to gastric sleeve (Table 2).

Table 2. Comparison of the anthropometric * and body composition * characteristics of 57 adult patients submitted to bariatric surgery, according to sex, age groups, and type of surgery.

	Sex			Age Groups			Type of Surgery		
	Women (*n* = 43)	**Men (*n* = 14)**	*p* **	**18–44 Years (*n* = 35)**	**45–69 Years (*n* = 22)**	*p* **	**Roux-en-Y Gastric Bypass (*n* = 23)**	**Gastric Sleeve (*n* = 34)**	*p* **
% of weight loss	9.2 (3.2)	12.8 (5.2)	<0.001	10.8 (4.6)	9.8 (3.3)	0.287	11.0 (4.8)	9.9 (3.6)	0.148
% of BMI loss	9.3 (3.9)	12.6 (6.7)	0.010	10.7 (4.8)	9.8 (3.9)	0.502	11.3 (5.1)	9.6 (4.0)	0.047
% of waist circumference loss [a]	8.9 (7.1)	9.2 (6.3)	0.286	9.5 (7.3)	8.0 (4.5)	0.490	10.3 (7.5)	8.2 (5.3)	0.152
% of fat mass loss [b]	1.7 (3.8)	4.1 (4.8)	0.337	4.1 (4.8)	1.7 (3.5)	0.103	2.0 (7.2)	2.5 (3.5)	0.875
% of free-fat mass loss [b]	1.7 (3.8)	4.1 (4.8)	0.337	4.1 (4.8)	1.7 (3.5)	0.103	2.0 (7.2)	2.5 (3.5)	0.875
% of skeletal muscle mass loss [b]	7.9 (4.5)	8.9 (5.5)	0.122	8.7 (6.8)	8.0 (6.3)	0.081	9.0 (7.3)	8.0 (3.5)	0.335

* Values are expressed as median and interquartile range; ** *p* values determined with Mann–Whitney test for independent samples. [a] *n* = 48. [b] *n* = 52.

4. Discussion

This study demonstrates that the anthropometric and body composition parameters of weight, waist circumference, fat mass, fat-free mass, and skeletal muscle mass all diminish shortly after bariatric surgery. Although the percentages of weight and of BMI loss were higher in men than in women and the percentage of BMI loss was higher in patients submitted to Roux-en-Y gastric bypass compared to those receiving gastric sleeve surgery, there was still a decrease in the aforementioned parameters, regardless of sex, age, and whether patients underwent Roux-en-Y gastric bypass or gastric sleeve surgery. Moreover, there was a reduction from pre- to post-surgery in the proportion of participants with class III and class II obesity, as well as of those categorized as having very high cardiometabolic risk.

It should be emphasized that, despite the decrease in total fat-free mass and skeletal muscle mass, the percentage of fat-free mass increased after surgery, indicating an improvement in the body composition and nutritional status of these patients. Also, in the post-surgery evaluation, there was no record of any patients in the low skeletal muscle mass index class and most participants (96.5%) were classified as presenting high skeletal muscle mass index. In the postoperative period, the diet protocol included meal fortification with a modular protein supplement [1,19], which may attenuate skeletal muscle mass losses. The findings underscore the importance of supplementation in maintaining skeletal muscle mass.

In this study, the number of male participants was lower than the number of female participants, a pattern consistent with other study cohorts [20–23]. It is well known that men generally tend to underutilize healthcare services and pay less attention to self-image issues.

The reasons for this are multifactorial, including social, economic, cultural motivations, and shame. Men seem to be less worried about body image and weight issues, resorting to bariatric consultations at a later stage of the disease.

The results of this study show that men have a higher percentage weight loss and a greater reduction in BMI compared to women. In 107,504 patients, a mean reduction in BMI was observed in male patients from 38.7 kg/m^2 to 33.5 kg/m^2 and in female patients from 37.6 kg/m^2 to 33.7 kg/m^2 (5.2 kg/m^2 versus 3.9 kg/m^2), while the same tendency was reported (15.0 kg/m^2 versus 14.3 kg/m^2) but after 1-year follow-up [20]. In this study, in line with other studies [20], male patients had higher initial overall weight and BMI, which may, at least in part, explain these findings. Also, according to some authors, differences between the sexes may be related to body composition before bariatric surgery, as it is well known that men have more muscle mass and more visceral fat mass and women have more fat mass in general [20,22,23]. However, Kennedy-Dalby et al. [21], in a study carried out among a sample composed of 79 men and 79 women, reported no relevant male–female differences in weight loss and metabolic outcomes post-bariatric surgery at a 24-month follow-up. The different findings in our study may be related to different sample baseline characteristics.

In this sample, a reduction in the mean BMI from 37.9 kg/m^2 to 33.6 kg/m^2 was observed when comparing the pre-surgery to the post-surgery values, while other studies reported a reduction in the mean BMI from 37.0 kg/m^2 to 29.1 kg/m^2 approximately but for 5-year outcome data [6]. According to other studies, a total body weight loss of 8% was observed 3 years post-surgery [9]; however, in this study, with a shorter follow-up period, it was possible to observe a loss of between 9.2% and 12.8% in total body weight, depending on sex, age, and type of surgery. Although it is difficult to compare results that relate to different follow-up times, the present results highlight that short-term weight loss is more marked than longer-term weight loss. This, in turn, highlights the need to rethink the frequency of individualized nutritional monitoring and follow-up for these patients to maintain appropriate eating habits and lifestyle after surgery in order to sustain improvements in the medium to long term.

However, in addition to nonadherence to diet and physical inactivity, some of the underlying reasons suggested for insufficient weight loss are obesity-related health problems such as type 2 diabetes [23], depressive disorders, and genetic and hormonal changes. It should be noted that differences in weight loss may be due to factors apart from the surgery itself. Weight loss may be also impacted by sleep disorders, polymedication, and environmental factors as well as lifestyle, absorption, energy expenditure, and intake [23].

We found no differences in the anthropometric and body composition characteristics evaluated for the 18–44-year-old versus the 45–69-year-old cohort, which agrees with a previous study conducted among 1356 women and 289 men, following 1 and 2 years post-surgery (gastric banding or Roux-en-y gastric-bypass) [24]. The authors state that age did not affect the percentage of excess body weight lost by men who underwent either type of surgery, nor by women who underwent a Roux-en-y gastric bypass. However, different follow-up times make direct comparisons with the present study problematic [24]. At the same time, it is important to note that losing weight is harder for older patients, who view surgery as the best option. Compared to younger patients, their motivation and ability to adhere to a dietary regime tends to be higher. Thus, the possibility of a lack of significance regarding age in the present study due to the low sample size cannot be ruled out.

In a retrospective cohort study among 186 patients with obesity and type 2 diabetes who underwent Roux-en-Y gastric bypass or sleeve gastrectomy, Leyaro et al. [23] reported that those who underwent Roux-en-Y gastric bypass had significantly higher total weight loss, with a difference of 9.3 (95% confidence interval, 17.21 to 1.46) after 2 years and of

10.4 (95% confidence interval, 20.67 to −0.04) after 5 years ($p < 0.05$) [23]. In our sample, patients who underwent Roux-en-Y gastric bypass had a higher percentage BMI loss but they also had higher BMI in the pre-surgical evaluation. Differences in findings between the two studies may be due to different follow-up times, sample size, or obesity-related health problems, since, in our sample, only 1.2% presented with diabetes.

With regard to obesity-related health conditions, other studies suggest that the most common are diabetes and dyslipidemia, which is consistent with our findings [20–23].

Limitations of this study include its retrospective design that may not fully account for other confounding variables of patient outcomes, including patient choices and pre-operative preparation. Another limitation was the non-inclusion of post-surgical data on obesity-related health problems to compare and observe potential outcomes, albeit short-term. Moreover, the low sample size is an important limitation. It may have hampered the detection of differences in anthropometric characteristics between sexes, age groups, and type of surgery. In addition, the study would benefit from applying regression analysis to account for all these factors in a single model, instead of showing the breakdowns by sex, age groups, and type of surgery. Unfortunately, our low sample size precluded the performance of a regression analysis. Furthermore, this sample may not reflect the anthropometric, body composition, and other individual and lifestyle characteristics of patients eligible for surgery. Nevertheless, all eligible patients who underwent metabolic and bariatric surgery at a Multidisciplinary Obesity Treatment Unit of a private hospital during the study timeline (approximately 5 years) were included in the sample. Consequently, this number (57 participants) reflects our reality in terms of surgical treatment of obesity. Finally, the post-bariatric surgery improvement of several biochemical parameters has been demonstrated in a number of studies [6,9], but these parameters were not assessed in the present study.

This study sought to address the scarcity of data on short-term anthropometric and body composition changes pre- and post-surgery, specifically within a period of circa two months. This is relevant because understanding the immediate postoperative condition is important for developing personalized bariatric treatment plans and nutritional interventions that effectively address patients' needs, doubts, and fears in this critical early period. Most studies in this area are related to follow-ups at or after 6 months [20–24]; this study would appear to be the first attempt to characterize changes occurring within a very short time after surgery. Secondly, unlike several previous studies [20–22], the results presented here are exclusively attributable to surgery, as preoperative weight loss was not an objective due to the brief interval between the initial multidisciplinary appointment and the surgical procedure. Moreover, previous studies limited themselves to weight-related metrics (initial weight, weight loss, and weight regained) and BMI [6,9,21,23,24]. In contrast, this study conducted a comprehensive body composition assessment including fat mass, muscle mass and skeletal muscle mass, and waist circumference. These changes occurred within a short period following surgery and, despite the limited timeframe, indicated positive outcomes for these patients' nutritional status. Our results highlight the importance of close postoperative monitoring to ensure that changes in nutritional status are compatible with health, supporting ongoing fat mass reduction while tracking changes in skeletal muscle mass. Early assessment of body composition changes following surgery may enhance clinical practice, allowing dieticians to tailor their interventions to promote weight and fat mass reduction, while striving to preserve skeletal muscle mass.

In the future, a larger sample and a longer period of observation would improve the precision and reliability of the results leading to more accurate conclusions. Moreover, assessing nutritional status and body composition with more detailed data, including bioelectrical impedance analysis, body circumferences, and skinfold thicknesses data in the evolution of patients following bariatric surgery, would broaden our understanding of bariatric surgery outcomes.

In conclusion, this study shows that, even within a short period after bariatric surgery, patients present a better nutritional status and body composition, with significant decreases in weight, BMI, waist circumference, and fat mass being observed, whereas the percentage of fat-free mass increased. Despite decreases in skeletal muscle mass and skeletal muscle mass index, these parameters nevertheless remained high.

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Abbreviations

The following abbreviations are used in this manuscript:

BMI	Body Mass Index

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