Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity (2021) 26:1709–1717
https://doi.org/10.1007/s40519-020-00973-w

ORIGINAL ARTICLE

Weight regain and eating behavior in physically active and inactive women after 24 months of bariatric surgery

Letícia Santos dos Rodrigues[1] · Paulo Henrique Carmona de Vasconcelos[2] · Daniela Lopes Gomes[3]

Received: 26 May 2020 / Accepted: 27 July 2020 / Published online: 14 August 2020

Abstract

Purpose This research has tested the association between anthropometric profile and eating behavior according to the practice of physical activity in women with more than 24 months after bariatric surgery.

Methods It is a transversal study accomplished with 44 adult women, in which sociodemographic and anthropometric data of eating behavior as well as physical activity practice have been collected.

Results The average of overweight loss was satisfactory (> 50%), the average of weight regain was of 16.4 ± 11.2%, being the weight regain (kg) statistically lower in the physically active group ($p = 0.049$). There had been predominance of emotional eating in both groups (active $p = 0.025$; inactive $p = 0.040$); significant inverse correlation ($\beta = -0.286$; IC −0.317; −0,005; $p = 0.044$) between food restriction behavior and weight regain (%) depending on postoperative period; and the time of physical activity practice (min) has presented inverse correlation, statistically significant ($\beta = -0.311$; IC −0.048; −0,001; $p = 0.039$) on the weight regain (%) independent of postoperative period.

Conclusions The physically active participants have presented the lowest weight regain and predominance of emotional eating domain, evidencing the need to model eating behavior and to encourage the practice of physical activity in these patients.

Level III Case-control analytic study.

Keywords Bariatric surgery · Obesity · Eating behavior · Physical activity · Three-factor eating questionnaire

Introduction

Obesity has been considered a worldwide health problem [1]. In cases of severe obesity, in which conventional clinical treatment was not efficient, bariatric surgery (BS) has been indicated and has presented good results in weight loss and co-morbidity control [2].

A study with 40 participants collected physiological, social and psychological data before and 6 months after surgery (Roux-en-Y gastric bypass—RYGB—and Sleeve), in addition to studying predictive factors of weight loss after 18 years months. The authors conclude that a substantial part of the individual variation in weight loss was explained by a combination of basic patient characteristics, psychological profile and social conditions, as well as physiological, psychological and behavioral responses to surgery [3]). Other studies also suggest that the factors associated with weight regain, in diverse postoperative periods, were poor quality of diet and physical inactivity, behavioral components such as lack of professional accompaniment during postoperative and physiological

This article is part of topical collection on Obesity Surgery and Eating and Weight Disorders.

Letícia Santos dos Rodrigues contributed to the study by reviewing the literature, applying the instruments and checking the anthropometric data. Also contributed to the analysis and discussion of the study.

Paulo Henrique Carmona de Vasconcelos contributed to the research with the writing of the paper, assisting in the analysis of the data and in the discussion of the results. Also contributed to paper translation

Daniela Lopes Gomes contributed to the work idealizing the methodological design, assisting in data collection, application of instruments and statistical analysis. Also contributed to the data analysis and discussion of the results.

✉ Letícia Santos dos Rodrigues
leticiarodri2@gmail.com

Extended author information available on the last page of the article

adaptations [4, 5]. Thus, for the maintenance of positive results after BS, it seems to be indispensable to do alterations in lifestyle, among which we may name eating behavior and physical activity practice [6–8].

Eating behavior is one of the main determinants in patient's evolution after BS, considering that weight loss is favored by eating choices and their qualities [6]. Such aspects may vary according to the patient's behavioral profile. One of the ways to evaluate eating behavior is using the Three-Factor Eating Questionnaire (TFEQ-21) [7].

TFEQ-21 has been used in studies to evaluate eating behavior of bariatric patients [7, 9]. This instrument evaluates eating behavior in its three dimensions: Emotional Eating, related to the subject's tendency to increase food consumption facing challenging or stressful situations; Cognitive Restriction, which is defined by a set of rules and food suppression developed by the subject to maintain their weight; and Uncontrolled Eating, characterized by loss of control on the food's caloric portion or quantity [10]. Studies that proposed this instrument's usage in bariatric patients have been demonstrating predominance on eating restriction behavior in the first 2 years after surgery intervention due to the induction to reducing the caloric intake occurring in this procedure, and those patients fear regaining the already lost weight [11, 12]. However, 2 years after surgery patients may present eating profile associated with emotional eating or uncontrolled eating, which may be associated with lower weight loss in a long term [13]. Nevertheless, studies that analyzed eating behavior of patients undergone bariatric surgery are still scarce, especially ones comparing different surgical techniques. For example, studies that correlated physical activity practice with the eating behavior profile after bariatric surgery were not found.

Another important issue to be observed after surgery is the physical activity practice, which has been difficult to adhere to after BS [14]. In bariatric patients, physical activity has been associated with the reduction to cardiometabolic risk, inflammation, insulin resistance, and endothelial dysfunction in postoperative time [15]. Besides, it influences positively weight loss; whereas, physically active subjects who practice moderate or vigorous intensity physical activity present inferior BMI (Body Mass Index) and current weight to those physically inactive, as well as lower weight regain [8].

Therefore, it was this study's intention to analyze the association between anthropometric profile and eating behavior with physical activity practice in patients who underwent bariatric surgery for more than 2 years. It is hoped that, based on these data, it will be possible to infer future interventions to guide patients in lifestyle change strategies.

Methods

Patients and study protocol

This is a cross-sectional, descriptive and analytic study with a non-probability convenience sampling reaching 44 women, from 18 to 59 years of age, after bariatric surgery (Sleeve, $n = 14$; or RYGB, $n = 30$) techniques with a postoperative time of 24 months or more. Participants were reached by an extension project, linked to a public university in Belém, Brazil, which accomplishes the nutritional monitoring of patients undergoing bariatric surgery. This research was approved by the Ethics and Research Committee from the Health Science Institute/Federal University of Pará (number 2.170.863), fulfilling legal requirements of Resolutions 510/2016 and 466/12 of the Health National Counsel as well as all patients have signed Informed Consent. Excluded from the research were male patients; patients who have got pregnant after surgery; patients who have used any medicine that could mistake the anthropometric data interpretation; patients who had bariatric surgery through other surgical techniques; presence of psychiatric disorders; patients who did not live in Belém and, therefore, could not move into town; and those who refused to participate and to sign the Informed Consent. The project followed 92 patients, of which only 44 were eligible according to the criteria.

Data collection

Data collection was accomplished between June 2018 and June 2019, through interviews with patients at the previously scheduled nutritional consultations, where information was obtained on the sociodemographic characteristics (sex, age, marital status, income and schooling), anthropometrical (current weight, stature, lower stable weight achieved after surgery and BMI calculation), physical activity level of classification; and analysis of eating behavior through Three-Factor Eating Questionnaire (TFEQ-21).

Anthropometry

As of anthropometrical data, weight and stature were gauged according to the criteria proposed by Lohman, Roche and Martorell [16]. It was used a platform-type scale with a capacity of 200 kg and a precision of 100 g with a coupled stadiometer of 200 cm, with a precision of 1 cm. Body weight was gauged with barefoot patient with as little clothing as possible. Stature was measured with the participant in an upright position with arms relaxed at the side of the body, feet together and gaze directed at the horizon. From the weight and stature gauged, the BMI of the participants

was calculated (BMI = Weight/Height^2), obtaining the classification of nutritional status [1] that was registered in the form. Ideal weight was calculated from the Metropolitan Life Foundation Table—1983 (Ideal weight = 25 × height^2), as it is suggested by the Brazilian Counsel of Bariatric Surgery elaborated by the Brazilian Society of Bariatric and Metabolic Surgery [17]. To evaluate the percentage of excess weight lost (%EWL) after surgery, this following formula was used: %EWL = Weight loss in postoperative time × 100/Initial weight preoperative time – Ideal weight. The weight regain percentage (%WR) was estimated by calculating the weight gain percentage relative to the lowest weight achieved in postoperative time (Current weight–lower weight), considering significant weight regain when %WR is greater than or equal to 15% [18].

Physical activity

Practicing physical activity in free time was classified through the physical activity practice questionnaire adopted by the Ministry of Health on Risk Factors Surveillance Survey and Protection for Chronic Non-Transmissible Diseases by Telephone Survey [19]. It has been considered physically active in free time those participants who practiced 150-min physical activity per week at least [1].

Eating behavior

To evaluate eating behavior, the Three-Factor Eating Questionnaire (TFEQ) was used. TFEQ evaluates through 21 Likert scale questions of four options: 1—totally false; 2—false most of the time; 3—true most of the time; and 4—totally true. These scores are added to the emotional eating and cognitive restriction categories and the following mathematical operation is made: score = [(sum's total score–6)/18] × 100. To the uncontrolled eating category and the following mathematical operation is made: score = [(sum's total score–9)/27] × 100. This score may vary from 0 to 100; thus, it means that the behavioral pattern is more present when the score is higher in the subject's repertoire. In the present study, we used an adapted version of TFEQ, translated and authenticated to Brazil [10].

Statistical analysis

The Kolmogorov–Smirnov test for normality was applied to statistical analysis to be able to verify sample distribution, which did not have a normal distribution. Therefore, non-parametric tests were used for statistical analysis. The descriptive results were expressed in frequency or mean ± standard deviation. Mann–Whitney test was applied to evaluate the difference between anthropometric data and behavior domains according to the physical activity practice; Kruskal–Wallis test was applied with the intent of comparing eating behavior domains; and Spearman's correlation coefficient was applied to evaluate correlation between anthropometric variables and eating behavior together with weekly physical activity minutes, considering the level of statistical significance of $p < 0.05$. For tabulation and data analysis, SPSS software version 21.0 was used.

Results

Sociodemographic data and participants' surgery time data

No statistically significant difference was observed in relation to the surgical technique performed in terms of sociodemographic characteristics and postoperative time ($p > 0.05$). It is important to highlight that, on the average, participants had circa 40 years of age, a good schooling level and income, lived without a partner and had a 70-month mean postoperative time (Table 1).

Participants' anthropometric profile according to the physical activity practice

Regarding the initial and current BMI and the % EWL, there was no significant statistical difference between physically active or inactive participants ($p = 0.496$; $p = 0.445$; $p = 0.146$, respectively). However, it was observed that the physically active participants have presented a BMI average corresponding to the overweight classification, while the physically inactive participants had a BMI average classified as grade 1 obesity. Besides, %EWL average may be considered satisfactory, for it was higher than 50%. Weight regain average, in kilograms and in percentage, was statistically lower in the physically active group ($p = 0.049$ and $p = 0.042$, respectively) (Table 2).

This also stands out that the prevalence of weight regain was of 59,1% ($n = 26$) and, amongst the participants who have presented significant weight regain (higher than 15%), the average was of 11.5 ± 8.3 kg, equivalent to 16.4 ± 11.2% (Table 2).

Eating behavior

As demonstrated in (Table 3), no significant statistical difference was observed in the mean score of domains amongst the physically active and inactive groups. Nonetheless, a higher score was verified in the emotional eating domain in both groups ($p = 0.025$; $p = 0.040$).

Table 1 Sociodemographic profile and surgery time of women after 24 months of bariatric surgery

	Surgical technique ($n=44$)				p value*
	Gastric bypass ($n=30$)		Sleeve ($n=14$)		
	Mean ± SD	Median (P5–P95)	Mean ± SD	Median (P5–P95)	
Age (years)	41.9 ± 12.1	42.0 (22.0–59.0)	38.0 ± 11.5	38,0 (21,0–59,0)	0.305
Years of study	13.8 ± 2.6	14.0 (6.0–18.0)	13.9 ± 1.9	14,5 (11,0–18,0)	0.888
Family income (Real $)	6073.8 ± 3011.4	2862.0 (954.0–8586.0)	5451.4 ± 3117.9	2862,0 (954.0–111,448.0)	0.785
Marital status					0.450
With partner	11 (25.0)[b]	–	7 (15.9)[b]	–	
Without partner	19 (43.2)[b]	–	7 (15.9)[b]	–	
Postoperative period (months)	80,.5 ± 50.1	62,0 (51,7–71,7)	58.5 ± 16.6	51.0 (43.5–63.0)	0.746

[a]Mann–Whitney Test

[b]n (%)

Table 2 Anthropometric profile following the practice of physical activity in women after 24 months of bariatric surgery

	Physical activity practice ($n=44$)				p value[a]
	Active ($n=22$)		Not active ($n=22$)		
Anthropometric characteristics	Mean ± SD	Median (P5–P95)	Mean ± SD	Median (P5–P95)	
Initial body mass index (kg/m^2)	45.8 ± 7.6	45.2 (34.8–57.5)	44.7 ± 6.6	43.9 (38,.0–57.4)	0.496
Current body mass index (kg/m^2)	29.3 ± 4.7	29.9 (22.9–40.7)	30.6 ± 6.1	29.8 (20.8–43.7)	0.445
Overweight loss (%)	82.2 ± 22.4	90.7 (51.3–137.5)	69.3 ± 32.0	78.0 (0.0–132.3)	0.146
Weight regain (kg)	9.1 ± 6.8	7.6 (0.0–19.5)	13.8 ± 9.1	11.9 (0.0–30.0)	0.049
Weight regain (%)	13.2 ± 9.0	11.2 (0.0–29.2)	19.7 ± 12.3	20.7 (0.0–39.5)	0.042

[a]Mann–Whitney Test

Table 3 Eating behavior following the practice of physical activity in women after 24 months of bariatric surgery

Eating behavior domains	Physical activity practice ($n=44$)				p value[a]
	Active ($n=22$)		Not active ($n=22$)		
	Mean ± SD	Median (P5–P95)	Mean ± SD	Median (P5–P95)	
Food restriction behavior	53.4 ± 19.5	50.0 (5.6–77.8)	44.7 ± 21.7	50.0 (0.0–83.3)	0,148
Emotional eating	56.4 ± 32.9	63.9 (0.0–100.0)	57.7 ± 25.7	66.7 (16.7–100.0)	0,759
Uncontrolled eating	45.0 ± 24.9	42.6 (7.4–81.5)	50.1 ± 29.7	48.1 (3.7–100.0)	0,689
p value[b]	0.025		0.040		

[a]Mann–Whitney Test

[b]Kruskal–Wallis Test

Correlation between weight regain, eating behavior and physical activity practice

There was significant inverse correlation ($p=0.045$; $\rho^2=-0.259$) between eating restriction behavior and the weight regain percentage. Therefore, eating restriction behavior seems to be correlated with the lowest weight regain proportion. It was yet observed that the weight regain percentage has presented statistically significant inverse correlation with the physical activity practice time (in minutes) ($p=0.042$; $\rho^2=-0.272$); thus, practicing physical activity for a longer time seems to reduce weight regain. No association between physical activity practice and the diverse eating behavior domains was found. Moreover, eating restriction component has presented significant direct correlation with the physical activity practice time ($p=0.047$; $\rho^2=0.256$); so, eating restriction behavior seems to be associated with the practicing physical activity

behavior (Table 4). No statistically significant correlations were found between physical activity practice and the domains of cognitive restriction ($p = 0.359$; $\rho^2 = 0.155$), emotional eating ($p = 0.784$; $\rho^2 = -0.047$) and uncontrolled eating ($p = 0.579$; $\rho^2 = -0.094$).

When the correlation between weight regain and the Food restriction behavior was tested by controlling the BMI and overweight loss variables, the correlation remained significant ($\beta = -0.286$; IC -0.317; -0.005; $p = 0.044$). However, when the postoperative period was inserted, the correlation between food restriction behavior and weight regain lost statistical significance (Table 5).

When the correlation between weight regain and physical activity was tested by controlling postoperative period, the correlation between physical activity and weight regain increased the statistical significance ($\beta = -0.311$; IC -0.048; $-0{,}001$; $p = 0.039$) (Table 6).

Discussion

The present research found the physically active participants have presented the lowest weight regain and predominance of emotional eating domain, evidencing the need to model eating behavior and to encourage the practice of physical activity in these patients in clinical practice.

As for the sample's sociodemographic characterization, they corroborate with other studies that also evaluated age, schooling, and income [5, 20]. Nevertheless, it differs from Novelli et al. [7] that suggested the evaluation of marital status where the predominance of patients without partners was observed. No differences were found in the sociodemographic profile in relation to the surgical technique performed, demonstrating that participants could have had a good understanding about the surgery itself and about the postoperative treatment to be adopted.

On the %EWL, according to the Brazilian Association for Metabolic Syndrome Obesity Study [21], surgical treatment is considered well succeeded if overweight loss achieves 50% and if the subject does not present Grade 3 obesity; so, the evaluated patients achieved satisfactory results after surgery for those who are physically active had a %EWL 81.0% with an overweight diagnosis, and those who are physically inactive had a %EWL 69.3% with a Grade 1 obesity diagnosis, according to the BMI.

Furthermore, both physically active and inactive participants had presented morbid obesity in preoperative time and, after at least 24-month surgery, the physically active group presented overweight status; while the physically inactive group still had a BMI average classified as light obesity. Such results are similar to the ones found by Silver et al. [22] in a study with 140 patients who undergone RYGB with a postoperative from 1 to 4 years time in order to determine self related weight control, diet and physical activity behavior in those subjects. They observed that those patients' preoperative time BMI were compatible with the morbid obesity diagnosis, besides that, between patients who practiced moderate or intense physical activity at least three times a week, with an average daily duration of 54.7 min, the current BMI was lower when compared to those physically inactive, and the increase of this value was associated with the shorter time involved in physical activity.

Physical inactivity observed in the present study in some patients can be justified by possible limitations. According to Dikareva et al. [23], bariatric patients present some obstacles for the accomplishment of physical activity, such

Table 4 Significant correlations between weight regain, eating behavior and physical activity practice in women after 24 months of bariatric surgery

Weight regain (%)	ρ^2	p value[a]
Food restriction behavior	−0.259	0.045
Physical activity time (min)	−0.295	0.026

[a] Spearman Test

Table 5 Correlation between weight regain and food restriction behavior in women after 24 months of bariatric surgery

	β	IC 95%	p value[a]
Model 1			
Food restriction behavior	−0.286	−0.317 to −0.005	0.044
Body mass index (kg/m^2)	0.047	−0.353 − 0.500	0.731
Overweight loss (%)	−0,414	−0.276 to −0.057	0.004
Model 2			
Food restriction behavior	−0,234	−0.286–0.023	0.093
Body mass index (kg/m^2)	−0.045	−0.509–0.370	0.751
Overweight loss (%)	−0.414	−0.272 to −0.060	0.003
Postoperative period	0.276	−0.003–0.150	0.059

[a]Linear regression; Dependent variable: Weight regain (%); covariate: Food restriction behavior and Postoperative period (months), β = regression coefficient

Table 6 Correlation between weight regain and physical activity in women after 24 months of bariatric surgery

	β	IC 95%	p value[a]
Model 1			
Physical activity	−0.312	−0.050 to 0.000	0.049
Model 2			
Physical activity	−0.311	−0.048 to −0.001	0.039
Postoperative period	0.347	0.014–0.170	0.022

[a]Linear regression; Dependent variable: Weight regain (%); covariate: Physical activity and Postoperative period (months), β = regression coefficient

as restriction due to patients' weight, surgery collateral effects, body displeasure, psychological health impairment, access' reduction to adequate installations, lack of knowledge about the importance of physical activity and climate factors. However, authors stand out that facilitating factors to physical activity are postoperative time weight loss, health maintenance, body satisfaction and active support relations as main stimuli to physical exercise by such subjects.

Ouelette et al. [14] found that the practice of physical activity presents difficult adherence in the initial postoperative period, despite the expectations of the patients and that the early postoperative period can be a time for behavioral intervention. Therefore, studies which manipulate the mentioned variables are necessary to verify the effects of physical exercises' adherence after long-time bariatric surgery.

In the present study, it was also possible to observe lower weight regain in physically active subjects who presented as well a longer physical activity time. Such results are similar to the ones found by Amundsen, Strømmen, and Martins [24] with 49 women who underwent RYGB when evaluating the relation between weight regain percentage and physical activity practice. In the study, it was possible to observe that the group with insignificant weight regain (weight regain $\leq 15\%$) had a moderate daily physical activity practice average of 81,0 min/day; while the time spent in daily moderate activities from the group with considerable weight regain (weight regain $> 15\%$) was of 41.0 min/day. Furthermore, this last group had a lower life quality level.

In another research accomplished by Monpellier et al. [8]. With 4569 patients who underwent RYGB, when analyzing the practice of physical activity in both preoperative and postoperative time, it was found an improvement in adherence of practice until 15 months of postoperative; yet, at 24, 36 and 48 months after surgery, there has been a gradual reduction in this activity's level. Besides, physical activity in these patients has been positively associated with a lower weight regain.

Thus, such practice should be encouraged in these individuals to ensure weight loss after surgery and reduce the chances of weight regain, given the inverse relation found between physical activity practice and weight regain, depending on postoperative period, in the present research. It is important to note that the lack of adherence to the physical exercise practice in preoperative time should not be an impediment to authorize individuals to undergo surgery, for this adherence to the physical exercises may be favored in postoperative time.

In this study, although weight regain was lower in physically active individuals, there was a high frequency of weight regain in the studied participants, which may predispose to the development or recurrence of co-morbidities associated with overweight [25]. In a study accomplished with 100 patients who underwent RYGB from 1998 to 2008, weight regain of 10% in relation to the lowest weight achieved was common after two–year surgery and has been associated with the return of at least one analyzed co-morbidity, which had reduced its frequency by 64% after surgery [4]. Therefore, it is evident the necessity of monitoring this patients' health in order to avoid co-morbidities recurrence and a worse health in late postoperative.

In the present study, there was still the predominance of emotional eating independent of the surgical technique performed. According to Natacci, Ferreira Junior [10], emotional eating is characterized by the subject's susceptibility in altering their eating pattern in face of humor changes or difficult situations. This result is in accordance with the result found by Mathus-Vliegen [26], who analyzed eating behavior of 236 patients who underwent Sleeve or RYGB techniques through Dutch Eating Behaviour Questionnaire (DEBQ), and observed that in those individuals with more than 5 years of postoperative time, there was predominance of emotional component and these ingested higher quantities of food when they were anxious or faced challenging situations. It is emphasized also that the patients presented as well lower overweight loss.

In Monpellier et al. [8] study, when they analyzed eating behavior through DEBQ, and its relation with weight regain in 4569 patients of 24, 36 and 48 months after RYGB, they demonstrated predominance of eating behavior by the time of 48 months after bariatric surgery, which has presented direct correlation with weight regain suggesting that patients who showed predominance of emotional eating behaviors in such period of time regained more weight. In Novelli et al. [7]. Study, when they analyzed eating behavior through TFEQ-21, it was also found a significant negative relation between the emotional eating domain and the overweight loss, independent of age, schooling and postoperative time.

Subramaniam et al. [27], when analyzed predictors related to weight loss, including eating behavior through DEBQ, in 57 patients undergone different surgical techniques (RYGB and Sleeve) and in different moments, such as: before surgery; 3 months and 6 months after surgery, observed that age increase, BMI higher value and higher scores of emotional eating, besides external eating influences, were inversely associated to total weight loss during such time. These discoveries suggest that the characteristics of preoperative eating behavior do not disappear during the initial stages after surgery and may affect weight loss during this initial period of quick weight loss. Still according to the authors, patients who present emotional eating behavior have more difficulty to diet adherence and control which is related to unsatisfactory weight loss.

Gradaschi et al. [6], in a study with 88 patients undergoing behavioral and dietary intervention after RYGB and Sleeve, concluded in their study that dietary and behavioral support is indicated in all patients with Sleeve, while

RYGB is useful when weight loss is unsatisfactory. Thus, the relevance of verifying the emotional components of eating behavior during the patient's nutritional monitoring to favor a healthy weight loss and obtain better results in late postoperative time is to be emphasized in clinical practice.

Eating restriction behavior is characterized by a set of eating prohibitions and obligations to body weight maintenance or loss [10]. In this research, such behavior has presented inverse relation with weight regain and direct correlation with time of physical activity. According to Al-Najim, Docherty, and Le Roux [28], the presence of a more restrict eating pattern is common in individuals who underwent bariatric surgery, because the procedure itself induces to anatomical and physiological alterations, such as, these patients tend to change the consumption of high-fat and -sugar foods to healthier options and, thus, ensure weight maintenance.

A study with 95 women who underwent RYGB with 24 months or more of postoperative time, when analyzed eating behavior through TFEQ-21, demonstrated that eating restriction domain was associated with the adoption of satisfactory habits, such as the intense or moderate physical activity practice for at least 150 min weekly, the adequate protein consumption, cereals, fruits, vegetables, adequate water ingestion and supplement use. Such behaviors are expected, for those patients who fear regaining weight and may adopt a healthier lifestyle to avoid it. Moreover, these habits may reduce in 18% weight regain chances, which demonstrates the importance of adopting healthy habits to prevent weight regain in late postoperative time [29].

Bradley et al. [30] accomplished a behavioral intervention to the development of positive psychological abilities in bariatric surgery late postoperative time. In this study, patients with weight regain higher or equal 10%, after at least 18 months surgery, received online orientations to the acquisition of healthy habits, stimulating physical activity practice and adequate eating. The authors verified that behaviors of food disinhibition, reactivity to internal stimuli, eating in response to depression, and eating compulsion were all correlated with weight regain. Therefore, interventions focusing the eating behavior alteration seem to contribute to weight loss and maintenance in late postoperative time. It is suggested, thus, more studies that may test different strategies of intervention to behavior changing and adoption of a healthy lifestyle after surgery.

The present study presents as limitation the small sample, yet it is emphasized that no studies were found in literature that could evaluate the association between eating behavior and the practice of physical activity with patients who underwent different surgical techniques except the one accomplished in the present research. Thus, we highlight the importance of this research to improve knowledge on eating behavior and its association with the practice of physical exercises, as well as reinforce the relation between physical activity practice and weight loss after surgery.

Conclusion

The present study verified that physically active participants presented a postoperative nutritional stage of overweight, while the physically inactive participants presented obesity. As well as weight regain mean was statistically lower in the physically active group.

The predominance of emotional eating domain was also discovered independent of physical activity practice, which directs the attention to the eating behaviors adopted in late postoperative time, as other studies have found an association between emotional eating and weight regain.

Finally, it was observed the inverse correlation between eating restriction behavior and weight regain and between the time of physical activity practice and weight regain. The direct correlation between time of physical activity practice and eating restriction domain was also observed, which reinforces the need for more experimental studies on behavior changing and adoption of a healthier lifestyle after surgery.

The importance of a multidisciplinary monitoring after bariatric surgery to understand eating behavior and encourage the practice of physical activity regularly is reinforced, to ensure the maintenance of satisfactory results promoted by the surgery.

What is already known on this subject?

The Three-Factor Eating Questionnaire (TFEQ R-21) was used to assess the eating behavior of women after Gastric Bypass in Roux Y or Sleeve techniques with a postoperative time of 24 months or more.

What does this study add?

There was a predominance of the emotional eating independent of physical activity, the eating restriction behavior and time of physical activity were inversely associated with weight regain.

Author contributions LSDR contributed to the study by reviewing the literature, applying the instruments and checking the anthropometric data. Also contributed to the analysis and discussion of the study. PHCDV contributed to the research with the writing of the paper, assisting in the analysis of the data and in the discussion of the results. Also contributed to paper translation. DLG contributed to the work idealizing the methodological design, assisting in data collection, application of instruments and statistical analysis. Also contributed to the data analysis and discussion of the results.

Funding Not applicable for that section.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This research was approved by the Ethics and Research Committee from the Health Science Institute/Federal University of Pará.

Informed consent Informed consent was obtained from all individual participants included in the study.

Consent for publication Patients signed informed consent regarding publishing their data.

Availability of data and material Not applicable for that section.

References

1. World Health Organization (2011) Global recommendations on physical activity for health. WHO, Geneva (SWI)
2. Schauer PR, Mingrone G, Ikramuddin S, Wolfe B (2016) Clinical outcomes of metabolic surgery: efficacy of glycemic control, weight loss, and remission of diabetes. Diabetes Care 39(6):902–911. https://doi.org/10.2337/dc16-0382
3. Nielsen MS et al (2020) Predictors of weight loss after bariatric surgery-a cross-disciplinary approach combining physiological, social, and psychological measures. Int J Obes (Lond). https://doi.org/10.1038/s41366-020-0576-9
4. Freire RH, Borges MC, Alvarez-Leite JI, Correia MITD (2012) Food quality, physical activity, and nutritional follow-up as determinant of weight regain after Roux-en-Y gastric bypass. Nutrition 28(1):53–58. https://doi.org/10.1016/j.nut.2011.01.011
5. Da Silva FBL, Gomes DL, De Carvalho KMB (2016) Poor diet quality and postoperative time are independent risk factors for weight regain after Roux-en-Y gastric bypass. Nutrition 32(11–12):1250–1253. https://doi.org/10.1016/j.nut.2016.01.018
6. Gradaschi R et al (2019) Disordered eating and weight loss after bariatric surgery. Eat Weight Disord. https://doi.org/10.1007/s40519-019-00749-x
7. Novelli IR, Fonseca LG, Gomes DL, Dutra ES, De Carvalho KMB (2018) Emotional eating behavior hinders body weight loss in women after Roux-en-Y gastric bypass surgery. Nutrition 49:13–16. https://doi.org/10.1016/j.nut.2017.11.017
8. Monpellier VM, Janssen IM, Antoniou EE, Jansen ATM (2019) Weight Change After Roux-en Y gastric bypass, physical activity and eating style: is there a relationship? Obes Surg 29(2):526–533. https://doi.org/10.1007/s11695-018-3560-x
9. Turkmen S, Andreen L, Cengiz Y (2015) Effects of Roux-en-Y gastric bypass surgery on eating behaviour and allopregnanolone levels in obese women with polycystic ovary syndrome. Gynecol Endocrinol 31(4):301–305. https://doi.org/10.3109/09513590.2014.994600
10. Natacci LC, Ferreira JM (2011) The three factor eating questionnaire-TFEQ-21: translation and administration to Brazilian women. Revista de Nutrição 24(3):383–394. https://doi.org/10.1590/S1415-52732011000300002
11. Engström M, Forsberg A, Søvik TT, Olbers T, Lönroth H, Karlsson J (2015) Perception of control over eating after bariatric surgery for super-Obesity—a 2-Year follow-up study. Obes Surg 25(6):1086–1093. https://doi.org/10.1007/s11695-015-1652-4
12. Bandstein M, Mwinyi J, Ernst B, Thurnheer M, Schultes B, Schioth HB (2016) A genetic variant in proximity to the gene LYPLAL1 is associated with lower hunger feelings and increased weight loss following Roux-en-Y gastric bypass surgery. Scand J Gastroenterol 51(9):1050–1055. https://doi.org/10.3109/00365521.2016.1166519
13. Järvholm K, Olbers T, Peltonen M, Marcus C, Dahlgren J, Flodmark CE et al (2018) Binge eating and other eating-related problems in adolescents undergoing gastric bypass: results from a Swedish nationwide study (AMOS). Appetite 127:349–355. https://doi.org/10.1016/j.appet.2018.05.005
14. Ouellette KA et al (2020) Physical activity patterns among individuals before and soon after bariatric surgery. Obes Surg 30(2):416–422. https://doi.org/10.1007/s11695-019-04186-8
15. Dantas WS, Gil S, Murai IH, Costa-Hong V, Peçanha T, Merege-Filho CAA et al (2018) Reversal of improved endothelial function after bariatric surgery is mitigated by exercise training. J Am Coll Cardiol 72(18):2278–2279. https://doi.org/10.1016/j.jacc.2018.07.094
16. Lohman TG, Roche AF, Martorell R (1988) Anthropometric standardization: reference manual. Champaign, Human Kinetics
17. Sociedade Brasileira de Cirurgia (2012) Bariátrica e Metabólica Consenso Bariátrico Brasileiro. SBCBM, São Paulo (SP)
18. Lasagni V (2018) Propuesta de guía para el tratamiento de la reganancia de peso después de cirugía bariátrica. BMI J 8:2
19. Ministério B, da Saúde V (2017) 2016: vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico: estimativas sobre frequência 26 estados brasileiros e no Distrito Federal em. Ministério da Saúde, Brasília (DF)
20. Bastos ECL, Barbosa EMWG, Soriano GMS, Santos EAD, Vasconcelos SML (2013) Determinants of weight regain after bariatric surgery. Arq Bras Cir Dig 26(1):26–32. https://doi.org/10.1590/S0102-67202013000600007
21. Associação Brasileira para o Estudo da Obesidade e da Síndrome Metabólica (2016) Diretrizes brasileiras de obesidade. São Paulo, ABESO
22. Silver HJ, Torquati A, Jensen GL, Richards WO (2006) Weight, dietary and physical activity behaviors two years after gastric bypass. Obes Surg 16(7):859–864. https://doi.org/10.1381/096089206777822296
23. Dikareva A, Harvey WJ, Cicchillitti MA, Bartlett SJ, Andersen RE (2016) Exploring perceptions of barriers, facilitators, and motivators to physical activity among female bariatric patients: implications for physical activity programming. Am J Health Promo 30(7):536–544
24. Amundsen T, Strømmen M, Martins C (2017) Suboptimal weight loss and weight regain after gastric bypass surgery—postoperative status of energy intake, eating behavior, physical activity, and psychometrics. Obes Surg 27(5):1316–1323. https://doi.org/10.1007/s11695-016-2475-7
25. Masood A, Alsheddi L, Alfayadh L, Bukhari B, Elawad R, Alfadda AA (2019) Dietary and lifestyle factors serve as predictors of successful weight loss maintenance postbariatric surgery. J Obes. https://doi.org/10.1155/2019/7295978
26. Mathus-Vliegen EMH (2007) Long-term health and psychosocial outcomes from surgically induced weight loss: results obtained in patients not attending protocolled follow-up visits. Int J Obes (Lond) 31(2):299–307. https://doi.org/10.1038/sj.ijo.0803404
27. Subramaniam K, Baixo WY, Lau PC, Chin KF, Chinna K, Kosai NR et al (2018) Eating behaviour predicts weight loss six months after bariatric surgery: a longitudinal study. Nutrient 10(11):1616. https://doi.org/10.3390/nu1011166

28. Al-Najim W, Docherty NG, Le Roux CW (2018) Food intake and eating behavior after bariatric surgery. Physiol Rev 98(3):1113–1141. https://doi.org/10.1152/physrev.00021.2017
29. Oliveira DA (2014) Qualidade e comportamento alimentar de mulheres após 24 meses ou mais de cirurgia b ariátrica [master thesis]. Universidade de Brasília, UNB, Brasília
30. Bradley LE, Forman EM, Kerrigan SG, Goldstein SP, Butrnia ML, Thomas JG (2017) Project HELP: a remotely delivered behavioral intervention for weight regain after bariatric surgery. Obes Surg 27(3):586–598. https://doi.org/10.1007/s11695-016-2337-3

Affiliations

Letícia Santos dos Rodrigues[1] · Paulo Henrique Carmona de Vasconcelos[2] · Daniela Lopes Gomes[3]

[1] Graduate Faculty of Nutrition, Federal University of Pará, Belém, Pará, Brazil

[2] Graduate Program of Neuroscience and Behavior, Federal University of Pará, Belém, Pará, Brazil

[3] Faculty of Nutrition and Program of Neuroscience and Behavior, Federal University of Pará, Belém, Pará, Brazil