Artículo Original / Original Article

Weight regain in association with macronutrient diet composition and quality of life in women at least 5 years after bariatric surgery

Recuperación de peso en asociación con la composición de la dieta de macronutrientes y la calidad de vida en mujeres con al menos 5 años después de la cirugía bariátrica

Denise Damin¹. <https://orcid.org/0000-0003-3569-1844>

Gabriel Beato^{1*}. <https://orcid.org/0000-0003-1490-2817>

Alex Crisp². <https://orcid.org/0000-0003-4683-9576>

Irineu Junior³. <https://orcid.org/0000-0001-6300-2319>

Thabata Weber⁴. <https://orcid.org/0000-0001-5588-4235>

Maria Rita Oliveira⁴. <https://orcid.org/0000-0003-1226-4364>

1. School of Pharmaceutical Sciences, Araraquara, State University of São Paulo Júlio de Mesquita Filho, UNESP, São Paulo, Brazil.

2. Post-Graduate Program in Human Movement Sciences, Piracicaba, Methodist University of Piracicaba, São Paulo, Brazil.

3. Bariatric Clinic, Piracicaba, São Paulo, Brazil.

4. Institute of Biosciences, Department of Human Sciences and Nutrition and Food Sciences, Botucatu, State University of São Paulo Júlio de Mesquita Filho, UNESP, São Paulo, Brazil.

*Corresponding author: Gabriel Cunha Beato.

School of Pharmaceutical Sciences, State University of São Paulo Júlio de Mesquita Filho, UNESP, Araraquara, Rua Rocha, 376, São Paulo, Brazil.

E-mail: gabrielcbeato@gmail.com

Este trabajo fue recibido el 30 de enero de 2021.

Aceptado con modificaciones: 25 de mayo de 2021.

Aceptado para ser publicado: 24 de junio de 2021.

ABSTRACT

Bariatric surgery has been shown to be the best alternative for the control of severe obesity, with improvements in patient quality of life. However, regaining weight due to inadequate nutrition can compromise surgery results. Objective: to investigate the relationship between weight gain and food consumption and quality of life among women at least 5 years after gastric bypass procedure. Methods: Seventy-three women who had bariatric surgery ≥ 5 years prior were evaluated for food consumption on 3 non-consecutive days and quality of life according to the dimensions of the BAROS tool. Results: Twenty two (29.7%) regained at least 10% of their weight. The group of women with stable weight loss had significantly lower carbohydrate consumption and showed no difference in energy consumption. Self-esteem and willingness to work also had a better score in this group, which contributed to a better quality of life score. Conclusion: From a weight regain below 10% after 5 years of bariatric surgery, the perception of quality of life among women changes. There are reasons for further studies on the effects of the proportion of macronutrients on dietary energy after bariatric surgery, including variations in the surgical technique and metabolic and anatomical variables.

Key words: Bariatric surgery; Food consumption; Macronutrients; Quality of life.

RESUMEN

La cirugía bariátrica ha mostrado ser una de las mejores alternativas para el control de la obesidad, aportando a la mejoría

en la calidad de vida del paciente. Sin embargo, recuperar peso debido a una nutrición inadecuada puede comprometer los resultados de la cirugía. Objetivo: investigar la relación entre el aumento de peso y el consumo de alimentos y la calidad de vida en mujeres al menos 5 años después del procedimiento de bypass gástrico. Métodos: 73 mujeres con al menos 5 años de cirugía bariátrica fueron evaluadas para el consumo de alimentos durante 3 días no consecutivos y la calidad de vida, según las dimensiones de la herramienta BAROS. Resultados: 22 mujeres (29,7%) recuperaron al menos el 10% de su peso. El grupo de mujeres con pérdida de peso estable tuvo un consumo de carbohidratos significativamente menor y no mostró diferencias en el consumo de energía. La autoestima y la voluntad de trabajar también tuvieron un mejor puntaje en este grupo, lo que contribuyó a un mejor puntaje de calidad de vida. Conclusión: a partir de una recuperación de peso por debajo del 10% después de 5 años de cirugía bariátrica, la percepción de la calidad de vida entre las mujeres cambia y existen razones para más estudios sobre los efectos de la proporción de macronutrientes sobre la energía alimentaria después de la cirugía bariátrica, con potencial influencia de variaciones en la técnica quirúrgica. Palabras clave: Calidad de vida; Cirugía bariátrica; Consumo de alimentos; Macronutrientes.

INTRODUCTION

Surgical treatment for obesity emerged in the 1950s, but it became a widespread procedure from the time that obesity was recognized as a global pandemic. At the same time, surgical techniques were improved, which widened the margins for benefit in relation to risk¹. The lasting weight loss produced by the surgery has been accompanied by metabolic advantages and improved quality of life, in the physical, social and affective dimensions². However, in addition to taking care of food intake and physical activities, life after surgery requires personal investment in adhering to a new life style, which also implies emotional adjustments³.

As a side effect, malnutrition caused by food restriction can lead to complications such as anemia, loss of bone mass and hypovitaminosis⁴. Thus, the consumption of food can influence the outcome of the surgery, either because of the excesses, with concomitant weight gain, or because of consumption limitations imposed by the surgery. However, measuring food consumption is not a simple task. Frequency questionnaires, records and registers allow estimating the consumption of macro and micronutrients, however they require a good memory, perception and training, which can incur errors of under and over reporting⁵. In a less direct way, micronutrient reserves can be evaluated by biochemical measures⁶. However, there is no way to do without these tools given the importance of food in the result of bariatric surgery.

Regaining weight, even a little, can frustrate expectations and represent a failure in the face of personal investment and compromise quality of life perception, which can also be influenced by other factors⁷. Weight regain can be expressed in units of kilograms of body mass, being more commonly expressed as a percentage of pre-surgery weight⁸. However, there is no consensus regarding the cutoff point, which can vary from 10 to 25% of the lowest weight reached⁸.

In the first year of surgery, excess weight loss occurs in an accelerated manner^{9,10,11}. Although a significant reduction in body weight occurs in the short term, many patients, after achieving maximum weight loss,

may recover their weight gradually over the years. Roux-en-Y Gastric Bypass (RYGB), the most widely used technique internationally, can provide a loss of 60 to 75% of excess weight, with maximum loss between 18 and 24 months after surgery¹². However, patients may obtain non-significant weight loss or even regain weight after a period of surgery¹³. Studies have shown weight regain at 24 months post-surgery^{4,12}.

A systematic review¹⁴ indicated that improvements in quality of life are more likely to occur in the first years after surgery, with greater changes in physical compared to psychological domains. In a more recent study, researchers have presented data on quality of life after long-term bariatric surgery from different analytic perspectives^{8,15,16}.

Few studies have been designed to assess the association between weight regain and quality of life^{8,16} or food consumption¹⁷.

The tools used to assess quality of life have been the health-related quality of life (HRQoL)^{8,15,16,18} and the Bariatric Analysis and Reporting Outcome System (BAROS)¹⁹. BAROS was developed in 1998 by Oria et al.²⁰ and updated in 2009²¹. However, depending on the historical series, some studies continued to be published based on the 1998 version of BAROS^{22,23}. BAROS has a dimension that assesses quality of life in a simplified way as the HRQoL, which was adopted as a reference standard.

In order to understand the challenge of understanding weight regain and its consequences, this study aimed to investigate the relationship between weight regain, food consumption and quality of life among women at least five years after the RYGB procedure, using a three-day food record and BAROS perception of quality of life.

METHODS

Study design and subjects

This was a prospective cross-sectional study resulting from the re-contacting of women who participated in a clinical study previously carried out between June 2010 and May 2013^{22,24}, approved by the Research Ethics Committee

of the Faculty of Medicine of Botucatu (UNESP) - under protocol number 1,682,409. The inclusion criteria for participation in this study was having participated in the two previous clinical studies^{22,24}.

Four hundred women completed the RYGB procedure and were followed up by the same multidisciplinary team in the pre- and post-operative period. After at least five years, a new contact via telephone was made to schedule an appointment for follow-up and an invitation to participate in the present study. In the telephone contact, 115 women were re-contacted. Of these, two reported being pregnant and eight were not interested in participating in the research. Of the 105 women who agreed to participate in the study, 32 missed the scheduled appointment. In this way, it was possible to assess a total of 73 women.

Definitions

In the present study, weight regain was defined based on a gain greater than or equal to 10% of body weight achieved one year after RYGB^{25,26}. The amount (%) of body weight regain was calculated using the following formula: (current body weight [kg] × 100 / body weight [kg] 1 year after surgery) - 100. Body mass index (BMI) was calculated using the formula: body weight [kg] / height [m²] and the excess weight loss (EWL) was calculated using the formula: EWL% = percentage of body weight lost in relation to excess weight. Vertical electrical bioimpedance (InBody230, Biospace, Seoul, South Korea, 2009) was used to measure weight.

Thus, women were categorized into a group with a weight regain equal to or greater than 10% (WR) and a group that achieved stable weight loss (SWL). In order to make comparisons between groups, baseline was defined as the period prior to the RYGB procedure. Information regarding baseline and one year after surgery were available through medical records.

Surgical procedure

All study participants underwent RYGB surgery through median supraumbilical laparotomy to construct a small gastric reservoir with dimensions of approximately 8 × 3 cm. Additionally, a reconstruction of the transit in Roux-en-Y was performed with a biliary loop 40 cm from the Treitz angle and a 150 cm food loop in a pre-colic position. Seventeen women received a 6.5 × 3.2 mm silastic ring, placed 3 cm above the anastomosis and attached to the anterior and posterior walls of the reservoir. All surgical procedures were performed by the same medical team in the same hospital.

Assessment of food consumption

The women were instructed, by telephone contact at the time they agreed to be part of the study, to carry out a self-registration of 72-hour food consumption, (three days, preferably not consecutive, and one weekend day)

reporting the home measurements of food and drinks consumed according to the Table for Assessment of Food Consumption in Home Measures²⁷. The request for this self-registration of food consumption had already been carried out for these same women in the preoperative period and these records computed the consumption of alcoholic beverages and food supplements. In this way, all subjects were familiar with the procedure. All food consumption records were collected and corrected during the consult with a nutritionist. DietPro[®] Software was used to estimate energy intake (kilocalories) and macronutrients (carbohydrates, proteins and lipids).

Quality of life

A simplified assessment of the five domains of quality of life was performed in the post-surgical assessment appointment using BAROS²⁰. Five domains were evaluated: self-esteem, physical activity, social relationship, sexual activity and work performance, assessed by a five-point Likert scale. Self-esteem can score up to 1 point (much worse than me = -1; worse than me = -0.5; the same as me = 0; better than me = 0.5; much better than me = 1). The other domains could score up to 0.5 points (much less = -0.5; less = -0.25; the same = 0; more = 0.25; much more = 0.5). Thus, the maximum score for quality of life was 2.5 points. This study chose not to score the percentage of excess weight loss, medical conditions, complications and other operations.

Other control variables

A complementary questionnaire included information on the prevalence of diseases, gastroesophageal reflux, vomiting, dumping syndrome, medications, dietary supplements, smoking, alcohol consumption and physical activity.

Statistical analysis

The normality and homogeneity of the data were assessed by the Shapiro-Wilk and Levene tests, respectively. For continuous variables, the comparison between groups (WR and SWL) was performed using the independent t-test or Mann-Whitney. Univariate and multivariate linear regression model (adjusted for age, time since RYGB surgery, preoperative BMI and energy consumption) was performed to evaluate the association of the variables of interest with body weight regain (dependent variable). The level of significance adopted was $p < 0.05$. All data were analyzed using SPSS version 20 (Chicago, IL, USA). Variables were expressed as median and interquartile range.

RESULTS

Among the 73 women, weight gain was observed in 30.1% (n = 22) over a period of 6.6 (6.2-7.1) years after surgery. The characteristics of the groups at baseline and one year after surgery, a reference point for weight

regain, are shown in table 1. There was no significant difference ($p>0.05$) between groups for any variable at baseline and in the body weight loss response one year after surgery.

Table 2 shows the variables related to body weight loss, food consumption and quality of life in the late postoperative period, whose mean time after surgery was greater than five years and did not show any difference between groups ($p=0.061$). The average weight gain exceeded 10 kg and around five units in the BMI (one year after surgery: BMI-WR= 29.8 kg/m², BMI-SWL= 29.3 kg/m²; last observation: BMI-WR= 34.9 kg/m², BMI-SWL= 29.9 kg/m²), with an average value close to, but less than 50% of EWL, considered for the success of the surgery. Among the WL group, three women did not meet the surgery success criteria, to which two more were added at the end of the observation period. In the SWL group, three women did not meet this criterion, which was maintained until the end. In addition, the time to reach the lowest weight in the WR group (1.3 ± 0.4 years) corresponded to half of the SWL group (2.6 ± 1.5 years).

There was no difference between groups for energy consumption. However, a higher proportion of carbohydrate ($p<0.001$) and lower fat consumption ($p=$

0.007) was observed, with an approximate 10% increase in the proportion of carbohydrate in the diet, offset by a reduction of approximately 5% in the proportion of fat consumed in the group that experienced weight gain. Regarding quality of life, the SWL group reported higher self-esteem ($p=0.002$) and a higher overall score ($p=0.025$).

The results of univariate and multivariate linear regression for the association between the percentages of weight regain after the first year with the BAROS domains of quality of life are shown in table 3. For univariate analyses, it was observed that the percentage of body weight was negatively associated with self-esteem ($\beta=-0.013$), physical ($\beta=-0.005$), and work domains ($\beta=-0.006$) and the total score ($\beta=-0.031$). However, for multivariate analysis (adjusted for time since surgery), the domains of self-esteem ($\beta=-0.010$), work ($\beta=-0.006$) and the total score ($\beta=-0.027$) remained significantly associated with body weight percentage.

No differences were found between groups regarding the prevalence of physical activity practices, alcohol consumption and controlled health variables. Also, there was no difference in the proportion of procedures with or without a ring in both groups.

Table 1. Group characteristics at baseline and one year after Roux-en-Y gastric bypass surgery.

Variables	Total (n= 73)	WR (n= 22)	SWL (n= 51)	p-value*
Age (years)	42.6 (38.5-47.6)	42.5 (36.7-46.8)	43.2 (38.6-48.0)	0.450
Body weight-pre (kg)	111.4 (103.6-123.7)	108.7 (103.4-124.0)	114.6 (104.2-123.6)	0.791
BMI-pre (kg/m ²)	43.1 (40.4-48.0)	41.7 (39.7-47.0)	43.4 (41.0-48.1)	0.493
Body weight-1 year (kg)	77.6 (71.0-84.3)	76.2 (67.0-90.4)	77.8 (71.9-83.9)	0.688
BMI-1 year (kg/m ²)	29.3 (26.7-33.0)	29.8 (25.7-34.0)	29.3 (27.3-32.7)	0.687
EWL-1 year (%)	70.6 (60.8-80.4)	67.6 (62.0-85.0)	70.9 (60.4-80.0)	0.987

WR: weight regain; SWL: stable weight loss; BMI: body mass index; EWL: excess weight loss. Data are expressed as median (interquartile range). * Independent t-test or Mann-Whitney. $p<0.05$.

Table 2. Comparisons of body weight loss, nutrition and quality of life in the late postoperative period between groups.

Variables	WR (n= 22)	SWL (n= 51)	p-value*
Time since RYGB surgery (years)	6.6 (6.2 – 7.1)	6,2 (5,9 – 6,7)	0,061
Current body weight (kg)	91.5 (79.2 – 104.4)	78,2 (72,7 – 84,4)	<0,001
Current BMI (kg/m ²)	34.9 (30.7 – 39.3)	29,9 (28,2 – 32,3)	0,002
Current EWL (%)	43.7 (34.9 – 66.7)	71,0 (61,1 – 77,3)	<0,001
Nutrition			
Energy (kcal/day)	1226 (1009 – 1362)	1054 (853 – 1362)	0,282
Carbohydrate (%)	57.1 (53.1 – 58.9)	48,2 (42,1 – 55,1)	<0,001
Fat (%)	28.0 (25.1 – 29.5)	33,3 (27,0 – 37,0)	0,007
Protein (%)	15.2 (13.2 – 18.9)	17,4 (14,5 – 22,2)	0,054
Quality of life			
Self esteem (score)	0.75 (0.50 – 1.00)	1,0 (1,00 – 1,00)	0,002
Physical (score)	0.50 (0.25 – 0.50)	0,50 (0,31 – 0,50)	0,136
Social (score)	0.25 (0.25 – 0.50)	0,25 (0,00 – 0,50)	0,759
Work (score)	0.25 (0.00 – 0.50)	0,50 (0,25 – 0,50)	0,088
Sexual (score)	0.00 (-0.25 – 0.25)	0,00 (-0,25 – 0,25)	0,748
Quality of life (score)	1.63 (1.25 – 2.00)	2,0 (1,75 – 2,50)	0,006

WR: weight regain; SWL: stable weight loss; BMI: body mass index; EWL: excess weight loss. Data are expressed as median (interquartile range). *Independent t-test or Mann-Whitney. p<0,05.

Table 3. Association of weight regain with quality of life variables.

Variables	Univariate*			Multivariate*		
	β -value	SE	p-value	β -value	SE	p-value
Self-esteem	-0.013	(0.005)	0.013	-0.010	(0.707)	0.032
Physical	-0.005	(0.002)	0.039	-0.004	(0.002)	0.089
Social	-0.004	(0.003)	0.147	-0.003	(0.003)	0.239
Work	-0.006	(0.003)	0.048	-0.006	(0.003)	0.048
Sexual	-0.003	(0.004)	0.381	-0.003	(0.004)	0.442
Quality of life	-0.031	(0.010)	0.003	-0.027	(0.010)	0.009

SE: standard error.

*Univariate linear regression model.

*Multiple linear regression model (adjusted for age, time since Roux-en-Y gastric bypass surgery, preoperative body mass index and energy consumption). p<0,05.

DISCUSSION

In this study, among the women analyzed after a minimum of five years post-bariatric surgery, one-third of them presented some weight regain in accordance with other studies, which, depending on the cutoff point, show variation between 16 and 37% at this time point¹⁶.

Of specific interest, the results of this study raise the hypothesis that weight regain may be influenced by the distribution of energy among macronutrients in the diet, with an emphasis on increased carbohydrate consumption in RYGB, pointing out gaps in knowledge for a more individualized dietary prescription. As in other studies^{8,16}, it was shown that weight regain interferes with quality of life, influenced mainly by the self-esteem domain. Regaining weight may result in the patient feeling failure that can be denounced in the eyes of society.

The cutoff point for classifying weight regain has varied from 10 to 25% of the lowest weight after surgery⁸, and in the present study 10% was adopted, since a less strict criterion would reach a very small number of women (less than 3% of women obtained over 25%, data not shown). The WR group had a median EWL of 43.7% (Table 2), when the individual criterion adopted by consensus to characterize failure has been 50%¹⁹, which shows that the weight regain considered here should be taken as a partial failure.

Energy balance is a determinant of body weight and, in this study, no significant difference was identified in self-reported food and energy intake, when comparing groups. On the one hand, the use of questionnaires to measure food consumption in terms of energy and nutrients, as well as expenditure on physical activity, has its limitations. On the other hand, the anatomical and physiological changes resulting from surgery cannot fail to be considered in this energy balance equation.

It is known that the variation in weight loss compared to isoenergetic diets with varying proportions of macronutrients is controversial. A higher proportion of proteins is usually associated with satiety²⁸. A higher proportion of carbohydrate intake with fat reduction in controlled studies promoted more significant weight loss, as shown in a meta-analysis²⁹. In the long term, a higher proportion of fat with reduced carbohydrate intake promotes modest, but significant weight loss, according to data from another meta-analysis³⁰. According to Bray and Tarino³¹, in the distribution of macronutrients in the diet, the increase in protein content at the expense of fat can be beneficial for weight loss; however, reducing energy consumption will always be the primary condition for this to happen.

The relationship between food consumption in energy and macronutrients was evaluated in the Swedish Obese Subjects cohort study. Food consumption was obtained through a semi-quantitative questionnaire self-applied to 1,610 individuals, at six months and every year until eight and ten years post-surgery³². When analyzing isoenergetic consumption patterns, weight regain was lower among those with diets with lower fat and higher protein content. However, in a Canadian study, twelve years after surgery, higher carbohydrate consumption was shown by individuals who regained weight¹⁷. These apparently contradictory results point out that there is a long way to go for dietary studies to better discern and elaborate evidence aimed at more specific dietary guidance. This involves methodological issues involved in the assessment of food consumption, as well as the anatomical and physiological changes resulting from surgical procedures. The use of biomarkers and the improvement of techniques for recording food consumption by digital means can improve these processes³³.

In the Swedish study³², a single self-referenced

questionnaire (although validated) was used, whereas in the Canadian study¹⁷, as in the present study, records of 3 non-consecutive days, including a weekend day, were used. Among the surgical procedures of the Swedish study, vertical gastropasty predominated, while in the present study, as well as in the Canadian study, the procedure was RYGB. The Swedish study was a non-randomized prospective study to evaluate the long-term results of surgery, while the Canadian study, like the present study, was a prospective cross-sectional study. It is observed that many factors may have influenced the results presented here. The strong point of the Swedish study approach was the sample size and the measurement of results over time. However, it would be interesting to know if more robust methods of collecting dietary information such as daily consumption records would result in the same outcome. On the other hand, both in this study and in the one from Canada, the contribution of protein in the diet increased in the SWL group and was very close to the 5% significance level. This suggests that the role of proteins should be further explored, considering that in the Swedish study, protein played a relevant role in the analyzed isoenergetic diets, either because of its greater satiety effect²³ or perhaps because of the anatomical barrier produced by surgery, which may impact meat consumption.

A relevant aspect in the context of weight loss by bariatric surgery is that some groups have insisted on ensuring a minimum protein intake of 60 g per day through supplementation in order to ensure muscle reserves, promote continued weight loss, and prevent osteoporosis³⁴. However, there is no scientific evidence that demonstrates benefits on health and weight loss, especially in the long term³⁵.

From a physiological anatomical point of view, questions arise, such as the fact that gastric surgeries can affect pancreatic exocrine production with impaired fat digestion³⁶. In this case, it can be speculated that a higher proportion of fat in the diet would not being absorbed, resulting in less energy input.

When considering the theory of postprandial response, greater deposition of body fat would be justified from visceral signs due to a greater release of insulin. In other words, a diet with a higher proportion of carbohydrates, in theory, could lead to greater deposition of body fat, a theory that converges with the present study³⁷. In that case, it would be necessary to know the quality of carbohydrates with reference to glycemic power. Sugary and sweet drinks have a higher glycemic index. However, the current analysis did not elaborate on this, since this was not a study under controlled conditions that would allow such a level of detail in food consumption.

Furthermore, differences in the biochemistry of macronutrient digestion and metabolism caused by each type of surgery is still unclear and it is necessary to integrate these differences with so many other variables to explain the complexity of the nutrition process after surgery. For example, RYGB alters the production of FGF-19 (Fibroblast growth factor) produced in the ileum in the presence of

bile, when it is known that FGF-19 and FGF-21 (produced by the liver) are involved, respectively, in the regulation metabolism of lipids and glucose³⁸.

On the one hand, the energy balance equation to explain weight gain has not yet been clearly defined; on the other hand, there is already sufficient evidence to affirm the negative influence of weight gain on the perception of quality of life in the late postoperative period. Even considering a minimum cutoff point (10%), as was the case in this study, the damage to quality of life in the face of weight regain was evidenced.

A sample of women from the same cohort (n= 285) as the present study had their quality of life assessed 6, 12 and 24 months after surgery, with progressive improvement in quality of life scores²⁰. Two years has been the time that marks the peak of the best results of bariatric surgery¹⁹.

Different psychosocial factors can interfere with well-being after surgery, such as weight loss, more or less successful emotional adjustments, adaptation to lifestyle, improvement and maintenance of comorbidities resolution, self-perception of body image, among others. In this study, the main quality of life domains were evaluated, such as self-esteem, physical activity, social relationships, sexual activity and work performance. It is interesting to note that a relatively small weight regain has mainly affected self-esteem and work. This may be related to social pressures and self-charging for success. One cannot fail to consider that the sample of the present study was composed of women and that, for them in particular, more than a disease, being overweight is a symptom in the face of an oppressive social system³⁹.

The WL group had more time since surgery time, which could be considered a bias in the study. However, it is important to highlight that in this group, the lowest weight was obtained within half the time as the SWL group. Weight recovery started at the beginning of the second year after surgery, while in the SWL group this was at the end of the third year. It is possible to speculate that weight regain may happen in the SWL group, but more slowly.

Given the results of this work, some methodological limitations are listed, which do not invalidate the conclusions, but are relevant. The evaluation of food consumption has challenged researchers and, even though the techniques for obtaining and processing data have been developed, questionnaires impose limitations⁶. The procedure used was the open RYGB, justified because it is the standard in public health in Brazil. The dimensions of the gastric reservoir, the alternative of using the Silastic ring and the measurements of the Roux-en-Y loops were part of the surgical routine of the service until 2014, but have been since revised. The need for controlled studies is urgent to generate evidence regarding the hypotheses raised here. This study decided to use only the BAROS quality of life questionnaire in its first version, even though we were aware of subsequent improvements. Not all dimensions were considered because of the limitations already identified. However, it was

maintained to preserve historical comparison²³. Although less sensitive, this instrument can identify impairment in the quality of life caused by a low weight regain.

CONCLUSION

In conclusion, body weight regain less than 10% after at least five years of the RYGB surgery negatively affects quality of life in female patients. There are reasons for further studies on the effects of the proportion of macronutrients on diet energy after surgery, with the potential influence of variations by surgical technique. Controlled studies could bring new evidence and make dietary recommendations more specific, contributing to better surgical results.

Founding Source: This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

REFERENCES

- Baker MT. The history and evolution of bariatric surgical procedures. *Surg Clin North Am*. 2011; 91: 1181-1201.
- Kolotkin RL, Kim J, Davidson LE, Crosby RD, Hunt SC, Adams TD. 12-year trajectory of health-related quality of life in gastric bypass patients versus comparison groups. *Surg Obes Relat Dis*. 2018; 14: 1359-1365.
- Spittal MJ, Frühbeck G. Bariatric surgery: many benefits, but emerging risks. *Lancet Diabetes Endocrinol*. 2018; 6: 161-163.
- Dalcanale L, Oliveira CPMS, Faintuch J, Nogueira MA, Rondó P, Lima VMR, et al. Long-term nutritional outcome after gastric bypass. *Obes Surg*. 2010; 20: 181-187.
- Shim J-S, Oh K, Kim HC. Dietary assessment methods in epidemiologic studies. *Epidemiol Health*. 2014; 36: 1-8.
- Picó C, Serra F, Rodríguez AM, Keijer J, Palou A. Biomarkers of nutrition and health: New tools for new approaches. *Nutrients*. 2019; 11: 1-30.
- Carrasco D, Appelpgren D, Nunez JC, Schlanbusch C. Changes in the significance of their own bodies in obese women who have undergone bariatric surgery. *Rev Chil Nutr*. 2014; 41: 40-45.
- King WC, Hinerman AS, Belle SH, Wahed AS, Courcoulas AP. Comparison of the performance of common measures of weight regain after bariatric surgery for association with clinical outcomes. *J Am Med Assoc*. 2018; 320: 1560-1569.
- Christou N, Efthimiou E. Five-year outcomes of laparoscopic adjustable gastric banding and laparoscopic Roux-en-Y gastric bypass in a comprehensive bariatric surgery program in Canada. *Can J Surg*. 2009; 52: 249-258.
- Novais PF, Raseira I Jr, Leite CV, Marin FA, de Oliveira MR. Food intake in women two years or more after bariatric surgery meets adequate intake requirements. *Nutr Res*. 2012; 32: 335-341.
- Sjöström L, Peltonen M, Jacobson P, Sjöström CD, Karason K, Wedel H et al. Bariatric surgery and long-term cardiovascular events. *JAMA*. 2012; 307: 56-65.
- Magro DO, Geloneze B, Delfini R, Pareja BC, Callejas F, Pareja JC. Long-term weight regain after gastric bypass: A 5-year prospective study. *Obes Surg*. 2008; 18: 648-651.
- Novais PFS, Raseira I, Leite CVS, Oliveira MRM. Body weight evolution and classification of body weight in relation to the results of bariatric surgery: Roux-en-Y gastric by-pass. *Arq. Bras. Endocr. Met*. 2010; 54: 303-310.
- Hachem A, Brennan L. Quality of life outcomes of bariatric surgery: A systematic review. *Obes Surg*. 2016; 26: 395-409.
- Major P, Stefura T, Dziurawicz B, Radwan J, Wysocki M, Małczak P, et al. Quality of life 10 years after bariatric surgery. *Obes Surg*. 2020; 30: 3675-3684.
- Voorwinde V, Steenhuis IHM, Janssen IMC, Monpellier VM, van Stralen MM. Definitions of long-term weight regain and their associations with clinical outcomes. *Obes Surg*. 2020; 30: 527-536.
- Reid RER, Oparina E, Plourde H, Andersen RE. Energy intake and food habits between weight maintainers and regainers, five years after Roux-en-Y gastric bypass. *Can J Diet Pract Res*. 2016; 77: 195-198.
- Ugarte C, Quinones A, Bustos C, Vicente, B. Percentage of total weight loss and weight regain in bariatric patients: A time perspective analysis. *Rev Chil Nutr*. 2020; 47: 41-49.
- Patel K, Askari A, Mamidanna R, Jain V, Adil T. Long-term BAROS scores and independent obesity-related co-morbidity predictors of failure after laparoscopic Roux-en-Y gastric bypass. *Surg Obes Relat Dis*. 2020; 16: 1954-1960.
- Oria HE, Moorehead MK. Bariatric analysis and reporting outcome system (BAROS). *Obes Surg*. 1998; 8: 487-499.
- Oria HE, Moorehead MK. Updated bariatric analysis and reporting outcome system (BAROS). *Surg Obes Relat Dis*. 2009; 5: 60-66.
- Raseira I, Coelho TH, Ravelli MN, Oliveira MRM, Leite CVS, Naresse LE, et al. A comparative, prospective and randomized evaluation of Roux-en-Y gastric bypass with and without the silastic ring: A 2-year follow up preliminary report on weight loss and quality of life. *Obes Surg*. 2016; 26: 762-768.
- Fiorani C, Coles SR, Kulendran M, McGlone ER, Reddy M, Khan OA. Long-term quality of life outcomes after laparoscopic sleeve gastrectomy and Roux-en-Y gastric bypass-a comparative study. *Obes Surg*. 2021; 31: 1376-1380.
- Schnor NPP, Verlengia R, Novais PFS, Crisp AH, Leite CV de S, Raseira-Júnior I et al. Association of 5-HT2C (rs3813929) and UCP3 (rs1800849) gene polymorphisms with type 2 diabetes in obese women candidates for bariatric surgery. *Arch Endocrinol Metab*. 2017; 61: 326-331.
- Cooper TC, Simmons EB, Webb K, Burns JL, Kushner RF. Trends in weight regain following Roux-en-Y gastric bypass (RYGB) bariatric surgery. *Obes Surg*. 2015; 25: 1474-1481.
- Roslin M, Damani T, Oren J, Andrews R, Yatco E, Shah P. Abnormal glucose tolerance testing following gastric bypass demonstrates reactive hypoglycemia. *Surg Endosc*. 2011; 25: 1926-1932.
- Pinheiro AB V. Table for Evaluating Food Consumption using Household Measurements. 5o ed. São Paulo: Atheneu; 2008, p.131.
- Alamshah A, Spreckley E, Norton M, Kinsey-Jones JS, Amin A, Ramgulum A, et al. L-phenylalanine modulates gut hormone release and glucose tolerance, and suppresses food intake through the calcium-sensing receptor in rodents. *Int J Obes*. 2017; 41: 1693-1701.
- Katsanos CS, Madura JA, Roust LR. Essential amino acid ingestion as an efficient nutritional strategy for the preservation of muscle mass following gastric bypass surgery. *Nutrition*. 2016; 32: 9-13.
- Tobias DK, Chen M, Manson JE, Ludwig DS, Willett W, Hu FB. Effect of low-fat vs. other diet interventions on long-term weight change in adults: A systematic review and meta-analysis. *Lancet Diabetes Endocrinol*. 2015; 3: 968-979.

31. Bray GA, Siri-Tarino PW. The role of macronutrient content in the diet for weight management. *Endocrinol Metab Clin North Am.* 2016; 45: 581-604.
32. Kanerva N, Larsson I, Peltonen M, Lindroos AK, Carlsson LM. Changes in total energy intake and macronutrient composition after bariatric surgery predict long-term weight outcome: Findings from the Swedish Obese Subjects (SOS) study. *Am J Clin Nutr.* 2017;106: 136-145.
33. Thompson FE, Subar AF, Loria CM, Reedy JL, Baranowski T. Need for technological innovation in dietary assessment. *J Am Diet Assoc.* 2010;110: 48-51.
34. Thibault R, Pichard C. Overview on nutritional issues in bariatric surgery. *Curr Opin Clin Nutr Metab Care.* 2016; 19: 484-490.
35. Ito MK, Gonçalves VSS, Faria SLCM, Moizé V, Porporatti AL, Guerra ENS, De Luca Canto G, de Carvalho KMB. Effect of protein intake on the protein status and lean mass of post-bariatric surgery patients: A systematic review. *Obes Surg.* 2017; 27: 502-512.
36. Alkaade S, Vareedayah AA. A primer on exocrine pancreatic insufficiency, fat malabsorption, and fatty acid abnormalities. *Am J Manag Care.* 2017; 23: S203-209.
37. Søndergaard Nielsen M, Rasmussen S, Just Christensen B, Ritz C, le Roux CW, Berg Schmidt J, et al. Bariatric surgery does not affect food preferences, but individual changes in food preferences may predict weight loss. *Obesity.* 2018; 26: 1879-1887.
38. Harris LALS, Smith GI, Mittendorfer B, Eagon JC, Okunade AL, Patterson BW, et al. Roux-en-Y gastric bypass surgery has unique effects on postprandial FGF21 but not FGF19 secretion. *J Clin Endocrinol Metab.* 2017; 102: 3858-3864.
39. Contreras JGM. Obesity: A Sociocultural Perspective. In: *Food, society and culture.* 1o ed Rio de Janeiro: Editora Fio Cruz; 2011. pp. 295-303.