



BJGH

Brazilian Journal
of Global Health

Revista Brasileira
de Saúde Global

Main factors for weight gain after bariatric surgery: literature review

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ABSTRACT

OBJECTIVE

To identify and relate the main factors that contribute to weight regain after bariatric surgery.

METHOD

Literature review, the database used in PubMed, with articles published in the last 5 years (2018-2023), using the Health Sciences Descriptors (DeCS): ((Bariatric surgery) AND (Weight regain)). Seventy one studies were selected for reading, and 15 of these were selected to compose the review, based on inclusion and exclusion criteria.

RESULTS

Important factors for weight gain or insufficient weight loss are patients who are older, male, have a high preoperative BMI, have psychiatric disorders and have comorbidities. After the weight loss plateau period requires patients to adopt restrictive measures, behavioral and nutritional modifications in the long term. Another study found that more than 76% of patients who underwent sleeve gastrectomy had significant weight gain after six years.

CONCLUSION

It is possible to conclude that bariatric surgery is the main treatment for obesity, however, to maintain the benefits of the procedure, multidisciplinary monitoring (medical team, psychologists, nutritionists, physical educators) is extremely important.

DESCRIPTORS

Surgery; Bariatric surgery; Weight regain.

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DOI: <https://doi.org/10.56242/globalhealth;2024;4;15;36-42>

INTRODUCTION

Obesity represents a global problem that has progressively increased in recent decades, according to the World Health Organization (WHO) approximately 650 million people around the world are obese, and around 4 million die each year as a result of being overweight or obese^{1,2}.

Therefore, this study was based on the findings of Noria *et al.* (2023)³, who reviewed the scientific literature seeking to find the prevalence, predictors and causes of weight regain after bariatric surgery.

In Brazil, the prevalence of obesity doubled between 2008 and 2019, from 12.5% to 25.9%, respectively. The estimate for 2030 suggests that three in ten adults will be obese. Projections estimate that approximately 2.6 billion dollars will be spent on federal costs directly related to cancer in the country, and of these, 62.8 million (2.4%) will be allocated to cancers related to excess weight. The study suggests that with the population's weight reduction, there will be a reduction in federal spending in 2040 directly related to cancer, ranging from 10.3 to 26.6 million dollars⁴.

Currently, bariatric surgery is considered one of the best treatments for obesity, it has been associated with significant weight loss, and consequently with possible remission and reduced risk of associated comorbidities, such as diabetes, metabolic syndrome, infertility, cancer, respiratory diseases and decreased of cardiovascular complications^{5,6,7}.

Over the years, several surgical techniques have been developed and described, such as Sleeve gastrectomy, gastric bypass (RYGB), One-anastomosis gastric bypass (OAGB), Single Anastomosis Duodeno-Ileal Bypass with Sleeve Gastrectomy (SADI-S), biliopancreatic diversion (BPD) with or without duodenal switch (DS)¹.

The Roux-en-Y Bypass technique, created by Manson and Ito, was considered for years the gold standard of treatment for obesity. It was the technique of choice in approximately 45% of procedures around the world. The main associated benefits were the reduction in perioperative morbidity and mortality, efficient weight loss, improvement in diseases associated with obesity and, finally, the durability of weight reduction. The main mechanisms that contribute to the adequate result are restriction in calorie consumption due to smaller gastric area, mild absorptive problems and hormonal changes (reduced ghrelin production, earlier secretion of peptide YY and changes in incretin levels, such as GLP 1)⁸.

Currently sleeve gastrectomy is the most common surgical approach. It demonstrated a reduction in morbidity and mortality rates, durable and less technically complex weight loss^{9,10}. However, some potential complications have been associated, such as Gastroesophageal Reflux Disease (GERD), insufficient weight loss (weight loss less than 50% of excess weight, 18 months after bariatric surgery)¹¹ and weight regain (progressive weight gain after sufficient weight loss), which in the first two years is around 5.7% and rises to 75.6% after 6 years^{9,10}. The previously mentioned complications were associated with revision surgery for sleeve gastrectomy. Revision surgery may have higher complication and mortality rates when compared to the first surgery¹⁰.

Weight regain after bariatric surgery is a frequent concern, as approximately one third of patients can regain around 25% of their total weight loss, and this will likely lead to recurrence of diseases associated with obesity and a reduction in the patient's quality of life. It is important to highlight that all types of bariatric surgery will have recurrence rates, either due to the chosen technique or due to factors intrinsic to the patient¹⁰.

Adequate weight loss is considered to be 50% or more of excess weight, with the last one being defined as, ideal weight subtracted from preoperative weight^{5,12}.

Numerous factors have been proposed to contribute to weight regain after surgery, including lifestyle, diet, behavior, genetic and metabolic factors, type of surgery performed and anatomical factors⁵.

Possible procedural failures that may occur are gastro-gastric fistula, dilation of the gastric fundus, enlargement of the gastric pouch, which may result in weight regain. The most frequent causes are poor adaptation to food (binge eating, eating disorders), failure to comply with dietary recommendations, return to previous eating habits, sedentary lifestyle,

compensatory physiological mechanism (hormonal changes that regulate food intake and the need for energy gain). Furthermore, psychiatric disorders, especially depression, are also considered as a possible cause of treatment failure¹³.

Clinical practice guidelines for patients undergoing bariatric surgery reinforce the importance of multidisciplinary monitoring in patient care, including perioperative dietary and physical activity counseling, long-term lifestyle support, and clinical management. Nutritional guidelines recommend regular intake of foods with adequate calories, as well as protein, fiber and reduced sugar consumption. Furthermore, practicing physical activity after the procedure is expected to increase daily calorie consumption, maintain muscle mass and function, and also improve cardiovascular function. According to the WHO (2020), recommendations are 150-300 minutes of moderate-intensity physical activity, 75-150 minutes of vigorous-intensity physical activity, or an equivalent combination of weekly moderate and vigorous-intensity aerobic physical activity and regular strengthening activity. muscle, recommended for health promotion¹³.

Bariatric surgery is currently considered one of the best intervention methods for obesity, reducing associated morbidities, improving quality of life and in the long term resulting in a reduction in mortality. However, weight regain after surgery reestablishes the risk of developing diseases associated with obesity, in addition to reducing quality of life. Therefore, knowledge of risk factors by health professionals is essential for adequate guidance of patients. Furthermore, as far as we know, there are few national studies that address this topic. This study aims to identify and relate the main factors that contribute to weight regain after bariatric surgery.

METHODOLOGY

Literature review updated by the scientific evidence found in the research by Noria *et al.* (2023)³. The database used was PubMed, with articles published in the last 5 years (2018-2023), using the Health Sciences Descriptors (DeCS): "Bariatric surgery", "Weight regain", linked by the operator boolean "and". 71 studies were selected for reading, and 15 of these were designated to compose the review. Based on the inclusion and exclusion criteria, with articles that mentioned bariatric surgery and weight regain being available in full, narrative, scoping and systematic literature review studies, meta-analysis, clinical trials and randomized clinical trials were selected. And finally, articles that do not address the researched topic were excluded.

RESULTS AND DISCUSSION

The results were grouped in table 1.

Author	Objective	Year of publication	Methods	Results / Discussion	Conclusion
Athanasiadis <i>et al.</i>	Check incidence and risk factors for weight regain	2021	Systematic review	Analysis of 32 studies including 7391 patients after RYGB and 5872 patients after Sleeve gastrectomy, approximately 17.6% had $\geq 10\%$ weight regain. The main risk factors related to weight regain are: gastric pouch diameter, gastric volume after surgery, anxiety, post-surgery time, sweets consumption, size, binge eating portion, genetics.	Weight regain of at least 1 in 6 patients after surgery. Preoperative advice and postoperative strategies that minimize the risk of weight regain.
Chierici <i>et al.</i>	Identify the best revision procedure after the first surgical approach	2022	Systematic review and meta-analysis	Biliopancreatic diversion with duodenal switch guarantees the best results for weight loss (1-3 years of 12.38% and 28.42%), followed by single anastomosis duodenoileal bypass (9.24% and 19.13%), bypass gastric with an anastomosis (7.16% and 13.1%) and finally, Roux-en-Y bypass (4.68% and 7.3%), when compared to reapproach by Sleeve gastrectomy. Duodenal switch and Roux-en-Y bypass techniques are associated with greater late morbidity when compared to revision surgery via sleeve gastrectomy. Patients undergoing duodenoileal diversion have a lower risk of weight regain when compared to those undergoing revision surgery via Sleeve gastrectomy (which is the most commonly performed).	Considering the observed results, single anastomosis in duodenoileal bypass with sleeve gastrectomy (SADI-S) and gastric bypass with one anastomosis are the main procedures performed after surgical failure, due to satisfactory short to medium and long term results.
Kermansaravi <i>et al.</i>	Define the role of gastric bypass with an anastomosis, after restrictive procedures (laparoscopic gastric banding, laparoscopic sleeve gastrectomy, sleeve banded gastroplasty)	2020	Systematic review and meta-analysis	Total of 1771 patients, in which the initial BMI was 45.70 kg/m ² , and decreased to 31.52 (after 1 year), 31.40 (after 3 years) and 30.54 (after 5 years) after revision surgery (gastric bypass with an anastomosis and mini gastric bypass). Type 2 diabetes: in the first 5 years remission occurred between 65-78% of patients, in some studies this result reached 100% remission, after gastric bypass surgery with an anastomosis and mini gastric bypass. Data on improvement in other comorbidities, such as hypertension, range from 58-94% 5 years after surgery.	Gastric bypass with one anastomosis and mini gastric bypass as revision procedures after bariatric surgery are effective, and the remission rate of obesity-related diseases is satisfactory, and postoperative complications are comparable to those of primary surgery.
Alyahya <i>et al.</i>	Demonstrate the prevalence of depressive symptoms and their short- and long-term effects in bariatric surgery	2022	Systematic review and meta-analysis	The prevalence of depression after bariatric surgery was 15.3% ($p < 0.001$) and could be severe, moderate or minimal depression, which affected 1.9%, 5.1% and 64.9% respectively. Depression is related to weight regain, eating disorders and worsening quality of life.	The prevalence of depression after bariatric surgery is high, and is associated with weight regain, eating disorders and decreased quality of life.
Zarshenas <i>et al.</i>	Analyze the relationship between bariatric surgery and diet quality for at least one year after surgery	2020	Systematic review	Most of the studies analyzed demonstrated a reduction in caloric intake after surgery, in addition to inadequate intake of micronutrients and protein, and excess fat intake. The analyzes demonstrated nutritional imbalances, insufficient adherence to multivitamin and mineral supplementation, in addition to limited patient monitoring.	Current evidence suggests that despite reducing caloric intake, bariatric surgery can result in unbalanced diets, inadequate intake of micronutrients, proteins and excessive fat intake.

Matar <i>et al.</i>	To determine the safety, efficacy and results of converting sleeve gastrectomy to Roux-en-Y bypass	2021	Systematic review and meta-analysis	Surgical conversion rate due to GERD was 30.4%, compared to 52% due to insufficient weight loss or weight regain. The baseline BMI considered was 38.5 kg/m ² , and after one year it was 32.1 kg/m ² .	The study demonstrated that conversion from Sleeve gastrectomy to RYGB has efficient weight loss and potential resolution of gastroesophageal reflux symptoms.
Clapp <i>et al.</i>	Analyze the rate of revision surgery and weight regain after sleeve gastrectomy	2018	Meta-analysis	After 7 years or more after surgery, the estimated rate of weight regain was 27.8%, with a range from 14% to 37%. The estimated total rate for revision surgery was 19.9%. It was divided into 13.1% due to weight regain, and 2.9% due to GERD.	Bariatric surgeons should be aware of the long-term outcomes of sleeve gastrectomy, especially in relation to revisions and weight regain.
Robinson <i>et al.</i>	Examine the effectiveness of technologies in helping patients undergoing elective surgery to change their health habits	2021	Systematic review	Three factors were effective: digital technology provision, implementation, and theoretical underpinning. Six of eight studies that referred to behavior change theories observed significant improvements in health behavior related to reduced weight regain and improved lifestyle choices for physical activity and diet.	Digital resources can be effective in changing behavior in patients undergoing elective surgeries.
El Ansari <i>et al.</i>	Analyze definitions, prevalence, causes, preoperative predictors, prevention and management strategies for weight regain and insufficient weight loss after bariatric surgery	2021	Scope review	There are many definitions for weight regain, but fewer for insufficient weight loss, resulting in inconsistencies in the reported prevalence of these two conditions. The mechanisms and preoperative predictors that contribute to weight regain are complex and multifactorial.	There is a need for more studies on current uncertainties to obtain a better evidence base for counseling and patient selection, which leads to better results.
Istfan NW <i>et al.</i>	To present a practical approach to recognizing weight regain in the population that underwent bariatric surgery	2020	Literature review	Weight regain can be classified as: light, moderate or rapid, ranging from 0.2% to <0.5%, 0.5% to 1% and more than 1% of the lowest weight achieved in 30 days, respectively. Treatment options include, dietary counseling, use of anti-obesity medications and revision surgery.	The approach cited in the article emphasizes the importance of long-term follow-up for all patients undergoing bariatric surgery.
Noria SF <i>et al.</i>	Summarize the prevalence, predictors, and causes of weight regain	2023	Literature review	In a study of 300 RYGB patients, 37% had significant weight regain during the 7-year follow-up (using the definition of $\geq 25\%$ increase in nadir weight - lower postoperative weight). Another systematic review revealed that approximately 76% of patients who experienced SG had weight regain within 6 years. In the cohort study with 1406 who attended RYGB, it revealed that weight regain was 5.7% after one year of nadir weight, followed by 10.1% after 2 years, 12.9% in 3 years, 14.2% in 4 years and 15% after 5 years. The biggest change occurred 2 years after reaching the nadir weight. In the same study, the incidence of weight regain was 23%, 51%, 64%, 69% and 72% after 1 to 5 years, respectively. The behavior of "snacking on food" can be present in 17 to 47% of patients, and has been associated with weight regain in several studies. Several systematic reviews and meta-analysis revealed that cognitive - behavioral, nutritional, physiological and lifestyle factors did not demonstrate an effect on postoperative weight loss.	The biggest causes of weight regain are associated with greater caloric intake after surgery due to increased appetite, unregulated or poorly adapted diet, inadequate physical activity and psychosocial stress. Weight regain is associated with the appearance of previously controlled comorbidities (type 2 diabetes, hypertension, among others). Behavioral and lifestyle measures have not demonstrated effectiveness. Revision surgeries can be effective in some cases, but have been associated with higher complication rates when compared to the first surgery.

Alexandrou A <i>et al.</i>	Summarize the data and available surgical options for treating patients with unsatisfactory weight loss or weight regain after Roux-en-Y gastric bypass	2022	Literature review	The excess weight loss achieved in RYGBP type I surgery is 61-90% at one year, and after five years it remains between 68-85%. However, surgery has a high morbidity rate in terms of nutrition, protein and calorie malnutrition occurs in 8-31% of patients, and the administration of total parenteral nutrition (TPN) was necessary for 14-21% of patients. DRYGBP type II surgery showed better results, despite weight loss being slower and less evident, but the absorption of calories and proteins in the elongated intestinal loop maintains better nutritional parameters in the short and long term. Excess weight loss was 48% in the first year, however malnutrition or need for TPN was less than 7%, and the need for revision was less than 6%. Another existing procedure is the conversion to BPD-DS (biliopancreatic diversion with duodenal switch), which is the most effective tool for super obese patients, however, it has been associated with high morbidity and mortality rates, in addition to nutritional problems due to malabsorption, requiring frequent hospitalizations and revision surgeries for evaluation. This procedure may be an option for patients who have already undergone RYGBP and have not had sufficient weight loss.	The data suggest that endoscopic procedures do not result in significant short- and long-term weight loss in patients with weight regain after gastric bypass. Conversion from Roux-en-Y gastric bypass to biliopancreatic diversion with duodenal switch provides the best results. Replacement of the jejuno-jejunal anastomosis proves to be nutritionally better in the long term, without significantly compromising weight loss and also because it is considered safe.
Cho YH <i>et al.</i>	Provide information on weight trajectory after metabolic bariatric surgery, definitions of postoperative weight regain, factors that contribute to weight regain after surgery, and strategies to prevent weight regain after LSG (Gastric Sleeve) or bypass in Roux Y.	2023	Literature review	Regular long-term monitoring by a multidisciplinary team is important as weight regain is multifactorial. Although lifestyle interventions are suggested, mainly physical activity, psychological and behavioral interventions, more studies are needed to evaluate intervention methods and the effectiveness of preventing weight regain.	More studies are needed on the methods and effectiveness of preventing weight regain. Anti-obesity drugs can be used to prevent weight regain after surgery, but more research is needed to determine the duration and type of drug used to prevent weight regain.
Rezende LFM <i>et al.</i>	Quantify the economic impact of cancer associated with excess weight and the potential for reducing cancer-related costs based on reducing the population's BMI.	2022	Top-down costing methodology and macro-simulation model	In 2030, 2.4%, that is, 62.8 million dollars, could be directed to direct care for patients with cancer associated with being overweight. The study projected savings of approximately 10.3 to 26.6 million dollars in 2040, from the reduction in the prevalence of overweight in 2030.	Excess weight could be responsible for up to 2.4% or US\$62.8 million in federal cancer-related costs in 2030. Potential savings were projected if the population's BMI were reduced, approximately US\$10.3 to 24.2 million in 2040, and these findings can assist in public policies to reduce the population's BMI and cancer prevention strategies in Brazil.

Bariatric surgery procedures are associated with several clinical improvements such as weight reduction, remission of comorbidities associated with weight regain and increased life expectancy. Furthermore, it influences physical and mental aspects such as daily activities, social relationships, body

image, eating behavior and mental health².

The study by Alyahya *et al.*² showed that one in five patients undergoing bariatric surgery has depression within three years after the procedure. The proportion of patients at risk of developing minimal depression after surgery was approxi-

mately 50% of interested patients. The findings in the study by Courcoulas *et al.*, cited by the author, reported a decrease in mild depression from 28% to 9.8% six months after surgery, followed by an increase of 12.2% and 15.6% in the second and third year after surgery, respectively. In the short term, depressive manifestations after surgery may not significantly influence weight regain, as the initial reduction is mainly related to metabolic changes induced by surgery and not to behaviors or psychological factors.

The first year after the procedure presents rapid weight loss, which generates a feeling of reward for the patient. However, after this period, the weight loss plateau requires patients to adopt restrictive measures and long-term behavioral and nutritional modifications^{2,7}. The study cites that excess skin resulting from weight loss can cause dissatisfaction in the patient, accompanied by unrealistic expectations regarding rapid weight loss and body contouring, a fact that implies greater stress for the patient. Patients at higher risk of developing depression should have regular monitoring, which can improve surgical effectiveness, increase weight reduction and improve quality of life in the long term^{2,12}.

It is extremely important to identify factors associated with insufficient long-term weight loss in patients seeking surgery, as this minimizes the risk of revision surgery, psychological disorders and costs associated with suboptimal weight. Patients of advanced age, male sex, high preoperative BMI, psychiatric disorders (anxiety, depression)¹² and with the presence of comorbidities (type 2 diabetes mellitus, hypertension, obstructive sleep apnea), present important predictors for weight regain or insufficient weight loss⁹. In a meta-analysis, depression after surgery was associated with weight regain, eating disorders and worse quality of life, these results reinforce the strong association between obesity and manifestations¹¹. Additionally, insufficient weight loss has been associated with impulsive eating, eating disorders, and depression^{2,11}.

According to El Ansari and colleagues¹¹, psychological factors can have a great influence on the patient's behavior and decrease weight loss, as it impedes the patient's motivation to properly follow a diet, exercise and other behaviors crucial to the success of the procedure. The study identified that one year after RYGB and LAGB (adjustable gastric banding) 47.5% who had psychiatric conditions had insufficient weight loss, and 29.5% gained weight. Individuals who had two or more psychiatric conditions had a high chance of not progressing or gaining weight when compared to individuals who had one or no psychiatric conditions.

Depression was identified in 45% of patients prior to the procedure, 12% within 6 months post-surgery and in 13% after one year, and although in the pre-operative period this factor does not determine satisfactory or unsatisfactory outcomes, after the procedure there is indication in strict relation with weight regain, feeling of loss of control when eating and concerns about body image¹¹. This study identified that patients with binge eating had an increase of 5.3 kg/m² in BMI compared to those without compulsive patients who obtained 2.4 kg/m², both five years after surgery¹¹. Another analysis revealed that compulsive patients showed significantly less weight loss, at 12 and 24 months after surgery, compared to those who did not present this condition^{3,11}. The prevalence of "grazing" behavior in patients varies from 17- 47% (depending on the method used), and was related to weight regain³.

Patients undergoing bariatric surgery, especially RYGB, have a higher chance of developing alcoholism after the procedure, due to "addiction transfer", in which the compulsive eating habit is replaced by alcohol abuse. This mechanism may be facilitated by the reduction of the enzyme alcohol dehydrogenase, present in the gastric mucosa, causing faster intoxication with smaller amounts of substance. Alcohol abuse has been linked to weight regain after surgery¹².

The systematic review by Zarshenas *et al.*⁷ showed the follow-up, for one year, of the postoperative period of patients undergoing major bariatric surgeries, and the results suggest that despite the benefits of the procedure, caloric intake remains inadequate after a year or more, with excess fat and reduced amounts of proteins⁷. To achieve the benefits of surgery and achieve the best nutritional profile, it is necessary to change eating habits, nutritional supplementation, as well as follow-up with a nutritionist, as 60% of patients who regain weight did not undergo adequate nutritional follow-

-up^{7,11,12}.

Maximum weight loss occurs in the first year after the procedure, with approximately 60% of patients losing more than half of their weight, followed by a period of stabilization and subsequent weight regain^{7,12}. Removing the greater curvature of the stomach generates increased production of pancreatic peptide YY and GLP - 1 (glucagon - like peptide - 1) and gastric inhibitory polypeptide hormones, which promote satiety and minimize hunger. As a consequence, the production of ghrelin decreases, and thus minimizes the amount of food ingested^{11,12}. Over the years, there is a decrease in ghrelin, leptin and incretin levels, leading to weight gain¹².

The main contributing factors for those in the last phase are excessive intake of carbohydrates, sugars, fats, alcohol, reduced consumption of fruits, vegetables, fiber, grains, hormonal factors and a sedentary lifestyle^{7,11,14}. Furthermore, other postoperative factors can influence, such as increased gastric volume after Sleeve gastrectomy, long-term follow-up after surgery, diabetes, binge eating, alcoholism, depressive symptoms, some studies have also associated it with an increase in preprandial ghrelin and a decrease in postprandial GLP-1 levels, however, more evidence is needed³.

The article by El Ansari *et al.*¹¹ describes a randomized case-control study, which followed a group for six weeks, and they achieved significant loss of excess weight (80% vs 64%) and BMI (6.48 ± 4.37 vs 3.63 ± 3.41) in 12 months when compared to patients with traditional care. Another intervention was carried out in this study regarding the patients' diet, in which one of the groups received specific portions of food, in addition to instructions on weight loss (the latter in both groups). The result under the intervention group was more promising with vast reduction in calories consumed in four months (- 108 vs - 116) and increased weight loss in 4 and 6 months (- 4.56% vs - 0.13%, - 4.07% vs - 0.14%, respectively), when compared to the traditional care group.

The article analyzed by Noria *et al.*³ with 300 patients undergoing RYGB during follow-up for seven years, it was found that 37% of patients had significant weight regain (25% increase in the lowest weight achieved / nadir weight). In another prospective cohort study with 1406 patients undergoing RYGB, the average weight regain was 5.7% after one year when the nadir weight was reached, with an increase of 10.1% in the second year, followed by 12.9% after three years, 14.2% after four years, and 15% after five years. The same study demonstrated that the incidence of weight regain ≥10% was 23%, 51%, 64%, 69% and 72%, between one and five years. A systematic review found that more than 76% of patients undergoing sleeve gastrectomy had significant weight regain within six years after surgery.

Post-bariatric hypoglycemia (Dumping Syndrome) has also been associated with weight regain, it occurs refractory to carbohydrate intake due to the change in intestinal anatomy that generates excessive insulin production^{11,12}. According to one study, after Roux-en-Y bypass surgery, approximately 54% of patients who regained weight experienced hypoglycemia. Around 79.2% of patients had 10% weight regain after 40 months of surgery, this value was even higher in patients who had hypoglycemia. The habit of "picking" ("grazing eating disorder") is defined by repeated episodes of eating small amounts of food accompanied by a feeling of loss of control, the prevalence varies from 16.6 - 46.6%. Due to the restrictive effect of the surgery, this type of behavior is more tolerated by the patient, but it interferes with weight loss, as 47% regain weight¹¹.

Furthermore, the surgical mechanism influences weight regain when there is enlargement of the gastric fundus and gastro-gastric fistula^{3,11}. Dilation of the gastric fundus leads to a reduced feeling of satiety, an increase in the amount of food ingested and subsequent weight regain. A study demonstrated that there was an increase in gastric volume from 120 ml immediately after surgery to 524 ml in five years, in patients with weight regain¹¹.

The studies analyzed in the article by Zarshenas *et al.*⁷ showed some food intolerances to red meat, rice, bread, pasta and vegetables, with a consequent reduction in the intake of these foods. However, these symptoms tend to improve after the gastrointestinal adaptation process.

According to Clapp *et al.*¹⁰, weight regain rates were higher than expected in the study, and increased as the follow-up

period extended^{3,9,10}. The standard rate of weight regain was approximately 27.8%, however, despite the result and complications, such as GERD, the procedure remains the most effective for treating obesity and its associated comorbidities^{9,10}.

According to the American Society for Bariatric Surgery, the incidence of revisional surgery has increased rapidly in the last decade, from 6% in 2011 to 15% in 2018¹⁴.

The study on intervention with patients through technologies such as cell phone applications and telemedicine services identified that these mechanisms are effective for patients undergoing elective surgery, especially in the short term¹⁵. As they encourage changes in the patient's habits and behaviors, physical activity, diet and consequent weight loss¹⁵. The results demonstrated great satisfaction on the part of patients undergoing intervention, mainly by facilitating consultation logistics, allowing more adequate monitoring with the responsible doctor and greater accessibility to the service¹⁵. The study analyzed by El Sanari *et al.* identified that 70% of patients approved the online method for monitoring, in addition, this format promoted significant weight loss in patients¹¹.

With regard to physical activity, only 10-24% of patients had access to information on health promotion related to the practice of physical exercise, and it can be considered one of the contributing factors to weight regain, as it contributes to the previous sedentary lifestyle and insufficient physical activity (according to the WHO guideline)^{11,12}.

Pharmacotherapy can be a great ally against weight regain, according to the study analyzed by El Sanari *et al.*, 319 patients with weight regain or insufficient weight loss after RYGB or sleeve gastrectomy, in which 54%, 30.3% and 15 % of the sample lost $\geq 5\%$, $\geq 10\%$ and $\geq 15\%$ (respectively) of total body weight with the use of medication. Those receiving topiramate were 1.9 times more likely to lose $\geq 10\%$ of their total body weight compared to those receiving other medications. Another study analyzed using topiramate, phentermine and/or metformin in young adults with weight regain indicated that 54.1%, 34.3% and 22.9% of the sample lost $\geq 5\%$, $\geq 10\%$, and $\geq 15\%$ of post-surgery, respectively, and those who used metformin obtained better results¹¹.

Liraglutide (GLP-1 analogue) was used in a study with 117 patients undergoing RYGB, sleeve gastrectomy or laparoscopic adjustable gastric band, and promoted significant weight loss (-6.3 ± 7.7 kg) in seven months after introduction regardless of the surgery performed. Weight loss remained significant even after 1 year of using the medication, however, nausea was the main side effect reported by patients¹¹.

According to the study by Istfan *et al.*¹², some drugs were associated with weight gain, such as diabetes medications such as thiazolidinediones, sulfonylureas, insulin. Some steroids such as glucocorticoids (dexamethasone, prednisolone), contraceptives (medroxyprogesterone acetate), first-generation (haloperidol) and second-generation antipsychotic medications (clozapine, quetiapine), antidepressants (paroxetine, amitriptyline, mirtazapine, lithium), antiepileptic medications (carbamazepine, gabapentin), antihistamines and, finally, antihypertensive medications (atenolol, propranolol, doxazosin).

CONCLUSION

It is possible to conclude that bariatric surgery is the main treatment for obesity, however, to maintain the benefits of the procedure, multidisciplinary monitoring (medical team, psychologists, nutritionists, physical educators) is extremely important. More studies are needed on the use of medications, duration and time to start treatment. Furthermore, the identification of predictive factors for weight regain, or insufficient weight loss, such as older age, male sex, high preoperative BMI, psychiatric disorders and the presence of comorbidities, is essential to track those who are at greater risk for these conditions, with the possibility of offering more access to resources and adequate monitoring.

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