

Review Article



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Definition, Mechanisms and Predictors of Weight Loss Failure After Bariatric Surgery

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ABSTRACT

It has been proven that surgery is more effective than non-surgical treatment in obese patients. However, this approach has several disadvantages, especially long-term weight loss. Weight loss failures can be broadly classified into two categories; insufficient weight loss (poor responder) and weight regain. However, a unified definition has not been established yet for each category, and there is no clear standard for the post-surgery time point to be used to assess weight loss failure. In addition, analyzing factors that contribute to weight loss failure will lead to strategies for reducing it. Therefore, many researchers have been interested in this subject and have published conflicting results. This review presents a definition for and describes the mechanisms and predictors of weight loss failure after bariatric surgery.

Keywords: Obesity; Bariatric surgery; Weight loss

INTRODUCTION

It has already been proven that surgical intervention is more effective and durable than non-surgical treatment in obese patients [1-4]. In other words, surgical treatment has shown significantly positive effects such as weight loss, improvement of comorbidities such as diabetes mellitus, hypertension, and hyperlipidemia, and reduction of cardiovascular risk [1,4]. These effects are durable and maintained for a long time [1]. However, as the numbers for bariatric and metabolic surgeries and long-term patient follow-ups increase, a significant number of patients face the possibility of revisional surgery [5-7]. Weight loss failure is known to be a major cause of revisional surgery [5-7]. Weight loss failure deteriorates the quality of life of the patient and causes the resurgence of comorbidities that eventually increase medical costs [5-8]. This is a gravely important long-term complication that is the dark side of bariatric surgery. Additionally, the significance of weight loss failure is emphasized for bariatric surgeons due to its technical challenges, and the high risks of morbidity and mortality involved in revisional surgery itself [9].

Until now, a unified definition for weight loss failure has not been established. There is also no clear standard for the post-surgery time point to be used for assessment of weight loss

failure due to the absence of large-scale studies. Currently, the prevalence of weight loss failure can have widely differing values due to the variety of definitions extant in the literature [10,11]. Nevertheless, analyzing the contributing factors and mechanisms involved in weight loss failure will strengthen the efforts to reduce its prevalence. Therefore, many researchers have been interested in this issue and have published numerous research reports [10,12-15]. Although many contributing factors have been suggested, most have shown inconsistent effects in published reports.

Therefore, this review will analyze the various definitions, mechanisms and predictors of weight loss failure after bariatric surgery, based on previous studies.

HOW TO DEFINE WEIGHT LOSS FAILURE AFTER BARIATRIC SURGERY?

In order to define weight loss failure after bariatric surgery, it is essential to determine the exact time point at which the nadir or lowest point of weight loss outcome post-bariatric surgery occurs by analyzing the results of highly cited previous studies. Data from the Swedish Obese Subjects (SOS) Study, the most cited report on the effects of bariatric surgery, show a weight loss effect of about 32% in Roux-en-Y gastric bypass (RYGB) [16,17]. According to the 15-year follow-up results of RYGB reported in Italy in 2020, the lowest body mass index (BMI) was shown at 2–3 years after surgery, and the maximum BMI was also at 2–3 years post-surgery, with 74.7% of patients achieving a total weight loss $\geq 20\%$ [18]. A Dutch clinical trial showed 7-year long-term results in a large patient group with RYGB 5516 and sleeve gastrectomy (SG) 3877 where the maximum weight loss effect was shown at 1 and a half years after surgery [19]. The data from a Japanese study showed the maximum per cent total weight loss and per cent excess BMI loss (EBMIL) at 1-year post-surgery regardless of type of bariatric surgery except for laparoscopic SG with duodenojejunal bypass [20]. The representative randomized controlled trial (SM-BOSS) compared the results of SG and bypass to show an EBMIL of about 70%, with the maximum weight loss effect in 2 years post-surgery regardless of the surgical types [21]. In the SLEEVEPASS trial, per cent excess weight loss (EWL) was the highest at 1-year post-surgery, with SG at 60% EWL and RYGB at 65% EWL. So far, the results have shown that the maximum weight loss outcomes appear between 1-year and 3-year post-surgery [22]. Lynch [23] reported that rapid weight loss occurs between 12 and 15 months after bariatric surgery, and this duration was labeled the honeymoon period. The long-term weight loss outcome has been divided into three trajectories: maintaining, regained/lost, or regained after honeymoon period, and the real work to treat obesity begins after that honeymoon time [23].

1. Successful weight loss after bariatric surgery

Before reviewing weight loss failure, it is essential to know and define successful weight loss. In most reports, weight loss of greater than 50% EWL between 1- and 2-year post-surgery is considered successful weight loss [24-26]. In addition to the criteria for excessive weight loss, Deguines et al. [27], define successful weight loss in SG as having a BAROS score greater than 3 points. The BAROS score is a weighted score that takes account of the resolution of comorbidities, the %EWL, the Moorehead-Ardelt quality of life score, and the existence of any postoperative complications and/or repeat surgery [28,29]. Deguines et al. [27] also defined successful weight loss after bariatric surgery with respect to the Reinhold criteria and Biron criteria as having the BMI value reduced to less than 35 or 40 [29-31].

2. Weight loss failure after bariatric surgery

Weight loss failures can be classified into two categories; insufficient weight loss and weight regain [11,32-37]. Insufficient weight loss (poor responder) is defined as less weight loss than some expected standards [38]. Second, weight regain is defined as a weight increase above a certain minimum point (nadir) [35,39,40]. Since some weight gain is expected and normal, pathologic weight regain has to be differentiated from the expected and normal weight regain.

The prevalence of weight loss failure after bariatric surgery ranges between 20–30%, and depending on the definition, category and surgery type, it can vary between 3.9 to 71% [11].

In order to define weight loss failure further, it is essential to decide the cut-off point and time point values.

1) Decision cut-off point

- Insufficient weight loss

Based on various studies, insufficient weight loss has been defined as a case where the % EWL is less than 50% or BMI is more than 35 based on the Reinhold criteria. Cut-off points have been presented in various ways, and absolute weight loss or EBML have also been used as standards [41-43].

- Weight regain

Many definitions of weight regain have been proposed, and at least 7 definitions published in a 2016 review can be summarized as follows: 1) BMI rises to ≥ 35 kg/m² after successful weight loss; 2) EWL percentage increases >25% from the minimum weight (based on Reinhold criteria); 3) EWL percentage <50% after achieving $\geq 50\%$ EWL; 4) Weight gain >10 kg from the nadir of body weight; 5) Maintain <20% of total weight loss; 6) Weight gain >15% of total weight lost initially; and 7) Increase of 5 kg/m² in BMI from nadir [35].

Also, a 2017 review collated the definitions presented in previous papers as follows [33]:

1) Weight regain of 10 kg or more from the minimum weight; 2) EWL percentage increase of 25% or more from the minimum weight [33]. A 2016 Facebook survey conducted by the International Bariatric Club showed that the most common definitions (based on survey votes) for weight regain were BMI exceeding 35 and a weight gain of more than 10 kg above the lowest weight point. The EWL percentage-related criteria described previously did not have selectors [34]. Two 2021 reviews have integrated the most recent studies [11,15]. In one review, the most used weight regain definition is the percentage weight gain from the nadir weight: $(\text{current weight} - \text{nadir weight}) / \text{nadir weight}$. This definition has been used as a guide in 19 existing reports and the cut-offs have varied from 10 to 50%. The next most used definition is the percentage between weight loss in nadir and current state: $(\text{current weight} - \text{nadir weight}) / (\text{preoperative weight} - \text{nadir weight})$ and this has been used in 14 reports, and the cut-off value has varied between 10 and 25% [15].

In the second recent review, the criteria presented in the existing literature were divided into 8 categories, and 4 of these were the most frequently used definitions, as follows: EWL percentage increase of 25 or more from nadir, a weight gain greater than 10–15% above nadir, a weight gain of more than 10 kg above nadir, or a weight gain of more than 10–25% of maximal weight loss [11].

2) *Decision time point*

Since many studies have used the nadir and maximal weight loss time points, it would be reasonable to review a highly cited clinical trial regarding these time points [11,15,35]. Weight loss after bariatric surgery occurs rapidly postoperatively up to 12 months after surgery [2,17,21,22]. One study reported that this weight loss trend slows down at 18–24 months postoperatively, and the SOS Study also considered the lowest time point for weight loss as 1 year post-surgery [17]. In addition, according to a multicenter study with 7 years of follow-up, body weight starts increasing 3 years after surgery [18]. Since previous studies have suggested different time points post-surgery for assessing weight loss failure (1 year, 1 year and 6 months, 2 years, 3 years), it seems reasonable to assess weight loss failure at the end of the honeymoon period, approximately 1–3 years after bariatric surgery [23].

3. What is meant by mechanisms and predictors of weight loss failure?

The etiology of weight loss failure is largely unknown. It is critically important to know the etiology of weight loss failure, because understanding the origin of this condition is a very important first step in treating and reducing weight loss failure by providing early intervention and intensive support to identified high-risk patients.

Based on the summary in a representative review article, the additional factors suggested in other studies were incorporated and summarized (**Table 1**) [15]. The following representative factors can be grouped into modifiable/non-modifiable, preoperative/intraoperative/postoperative, and surgery-related/patient-related factors [39,44-47].

1) *Anatomical/surgical factor*

The mechanism of weight loss failure is different for each operation. At first glance, SG may be associated with gastric dilation [11,15,48-51]. This is because restriction is eliminated, and a lot of ghrelin can be secreted [51]. SG can be divided into primary and secondary dilation. Primary dilation refers to the case where the fundus is stretched without dilation of the tube. This is a kind of hiatal hernia, caused by the angle of his is not properly exposed due to the thick visceral fat layer, or the fundus dissection is completely due to a past history of gastric banding. Secondary dilation refers to the case where the residual volume is more than 250 mL, and the gastric tube is stretched in a diffuse homogenous manner. It may have been physiologically stretched due to the eating habits of the patient, or surgical errors such as large remnant stomach due to large bougie size, incorrect resection of the remaining posterior wall of gastric folds, or small volume of antral resection/long length from the pylorus for first antral resection [51,52]. In RYGB, a large gastro-jejunal stoma diameter, gastric pouch dilation, and gastro-gastric fistula as a surgical complication may be associated with weight loss failure [11,15,39,53,54].

2) *Social demographics and anthropometrics of patients*

There have been many reports that the older age of patients is a factor impacting weight loss failure, although other studies have reported no correlation for this [11,15]. Patient social

Table 1. Consistent correlations with weight loss failure [15]

Consistent correlation	Factors
Positive	Gastro-jejunal stoma diameter, gastric volume following sleeve, anxiety, time after surgery, eating behaviors (sweets consumption, emotional eating, portion size, binge eating, loss of control/disinhibition when eating), genetics.
Negative	Postprandial serum GLP-1 level, eagerness to change physical activity habits, self-esteem, social support, fruit consumption

demographic factors such as being single, from low socio-economic status, working in food-related jobs, not having a full-time job, and low education may impact weight loss failure after bariatric surgery [12,15,39,55-57]. Preoperative BMI may also affect weight loss failure: the higher the preoperative BMI value, the higher the weight loss failure rate [12,15,58]. In some studies, it was observed that the higher the weight loss before bariatric surgery, the lower the weight loss failure post-surgery. In other studies, there was no effect between preoperative weight loss and weight loss failure rate [12,59,60]. The influence of gender in weight loss failure has also been a matter of debate [15].

3) Underlying disease and past medical history

It is accepted that underlying comorbidities, such as diabetes, blood pressure, hyperlipidemia, or high serum HbA1c and triglyceride levels, are a risk factor for weight loss failure [12,15,61,62]. In addition, if the patients have a history of abdominal surgery, childhood obesity may be associated with weight loss failure [12,15,56].

4) Behavioral factors of patients

Eating behavior is the most common behavioral factor impacting weight loss failure [14,63]. Grazing is the repetitive, haphazard eating of small amounts of food over a period of time, regardless of feeling hungry or full. Binge eating is eating large amounts of food in a short amount of time. It is usually accompanied by feelings of guilt, shame, and mental stress. When this is a pathological condition, it is called binge eating disorder. Loss of control eating is eating without control over what and how much you eat. Picking and nibbling refers to unplanned and repetitive eating between meals. Eating too much at night after dinner and nocturnal eating after waking up to the level of a pathological condition is called nocturnal eating syndrome. Emotional eating refers to a state in which negative emotional states affect diet. External eating refers to a condition where external stimuli such as smell and taste induce eating behavior, and restrained eating occurs when weight is controlled by controlling food intake [15,55]. Weight regain may also be related to a large portion size, the amount of food eaten at one time, a strong craving for food, and a fondness for sweet food [15,64,65]. In a recent highly cited study, weighing at least once a week was a factor in preventing weight regain. In addition, eating fast food more than once a week, eating even when full, eating all day, binge eating and loss of control eating, 4.5 hours of continuous sitting time are the risk factors for weight loss failure [61].

5) Psychological factors affecting weight loss failure

Depression, anxiety, alcohol and substance abuse, attentional impulsiveness, personality disorder, multiple psychiatric conditions, and low self-esteem may be associated with weight loss failure [15,61,63-65].

6) Individual adherence to personal rules of behavior

Strict adherence to personal rules of behavior impacts weight loss failure. Failure to follow dietary and nutritional rules, eating indiscriminately, showing a lack of adherence to regular and long-term outpatient follow-up, failure to follow exercise rules, and not checking personal body weight frequently has consequences for weight loss failure [14,15,55,61,65]. Therefore, the International Federation for the Surgery of Obesity and Metabolic Disorders criteria emphasize this role and evaluate the motivation of the patient for follow-up and compliance with rules for behavioral change such as self-monitoring body weight before surgery [66].

7) Social support

The social support network of a patient is composed of structural and functional support. It plays the role of stress buffering and is mainly played by friends and family. The bariatric support group is also a concept included in social support, and the bariatric support group program helps patients complete follow-up requirements. In addition, nutritionists work to correct patient behaviors that affect weight loss [14,15,67].

8) Physical inactivity

If patients do not follow recommendations for exercise and lead a sedentary life, they might be patients with poor access to exercise facilities [11,14,15,61,63,65].

A study speculates women with high weight loss failure have limited physical activity because they are housewives or have multiple part-time jobs, while patients who are retirees stay at home with their extended family and are not usually involved in physical activities [47].

9) Hormonal factors and genetic factors

Studies have reported that ghrelin, serotonin, glucose-dependent insulinotropic polypeptide, glucagon-like peptide-1, peptide YY, post-bariatric hypoglycemia, and leptin have an effect on weight loss failure. Other studies have shown that some genes are associated with weight loss failure when quality of life is lowered over time post-surgery [11,14,15,68-71].

CONCLUSION

Weight loss failure is classified into insufficient weight loss and weight regain. Criteria commonly used to assess weight regain include >25% EWL increase from the point of nadir, a weight increase >10% or 10 kg based on nadir weight, and a weight increase >10–25% based on maximal weight loss. The criterion commonly used to determine insufficient weight loss is that the EWL percentage should not reach 25–50%. It is recommended to evaluate weight loss failure at the end of honeymoon periods and 1–3 years after bariatric surgery. With regard to the question of having differing standards of weight loss depending on the type of surgery, a trend of higher weight loss failure in SG than in RYGB has been noted. However, so far, it seems appropriate to use similar standards for SG and RYGB. In addition, the numerous contributing factors of weight loss failure are complex and closely related to each other.

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