



Predictors of Success in Bariatric Surgery

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Abstract

Purpose of Review The goal of this review is to summarize the current literature on predictors of success in bariatric surgery. These predictors include clinical, psychological, behavioral, and socioeconomic factors. Successful bariatric surgery is defined by excess weight loss, as well as improvement in medical comorbidities and the patient's quality of life.

Recent Findings Successful bariatric surgery is dependent on clinical, psychological, behavioral, and socioeconomic factors. The choice of operation, as well as the starting body mass index (BMI), has the largest clinical effect on weight loss. The presence of maladaptive eating habits, such as binge eating and emotional eating, is strongly correlated with poor postoperative weight loss. The presence of psychiatric disorders such as depression and anxiety has mixed effects on postoperative weight loss. Socioeconomic factors are barriers to access to bariatric surgery and can affect weight loss.

Summary Success after weight loss surgery not only is measured by the amount of weight lost but also by the improvement/resolution of comorbidities. Weight loss after bariatric surgery is a complex interplay of various clinical, psychological, behavioral, and socioeconomic factors. The strongest predictors appear to be behavioral. Channeling efforts to improve behavioral and nutritional support should be the focus of research going forward. More long-term studies are needed to further define the importance and influence of these factors on post-bariatric surgery outcomes.

Keywords Bariatric surgery · Predictors of success · Outcomes · Psychological factors · Socioeconomic factors

Introduction

The severely obese (body mass index, BMI > 40) respond poorly to traditional diet and exercise based weight loss strategies. Although some may initially lose weight, the durability of this weight loss is rarely maintained long term [1]. Bariatric surgery provides a way to successfully treat the morbidly obese and achieve sustained weight loss [2]. In addition to the weight loss, the metabolic changes brought by bariatric surgery can improve or put into remission the comorbidities associated with obesity. Patients tend to also experience improvement in their psychosocial functioning and quality of life. Successful weight loss rates for bariatric surgery range

from 70 to 80% [3]. However, this still leaves 20–30% [4] of patients who fail to lose adequate weight [5].

Before continuing it is important to establish a definition of success in bariatric surgery. Success involves three main goals: weight loss, reduction of obesity-related comorbidities, and improvement in quality of life. Currently the most commonly used metric to report outcomes in the bariatric surgery literature is the percent excess weight loss (%EWL). The %EWL is the percentage of weight that is lost above and beyond the ideal body weight. For example, if a patient weighs 300 pounds and her ideal body weight is 150 pounds (based on an ideal BMI of 25), then her excess weight would be 150 pounds. A 50% excess weight loss would equate to 75 pounds of lost weight. Successful bariatric surgery has traditionally been defined as 50% EWL sustained beyond 2 years postoperatively. Success rates based on this measure have been reported between 70 and 80% and depend on which procedure is performed. There are higher success rates with gastric bypass and duodenal switch and slightly lower rates with sleeve gastrectomy. The laparoscopic adjustable gastric band (lap-band) has much lower rates of success, which contributes to this procedure rarely being performed today.

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The limitation of this definition of success is that it fails to recognize the other health benefits that come along with weight loss and metabolic surgery. Perhaps a better and more important metric of success is resolution of comorbidities and overall improvement in quality of life. Numerous studies have established the health benefits, and the positive effect bariatric surgery has on the improvement and resolution of diabetes, hypertension, obstructive sleep apnea, and hyperlipidemia. The Swedish Obese Subjects study is the first long-term, controlled trial that showed the effects bariatric surgery has on diabetes, cardiovascular disease, and mortality. The original study involved 2010 patients who underwent bariatric surgery with a follow-up of 10 to 20 years in later reports [10]. Bariatric surgery was associated with long-term reduction in mortality (hazard ratio (HR) = 0.71), incidence of diabetes (HR = 0.17), myocardial infarction (HR = 0.71), and stroke (HR = 0.66). After 2-year follow up, 72% of patients with diabetes were in remission; however, by 10 years, 50% of these diabetics had relapsed [6].

The Longitudinal Assessment of Bariatric Surgery (LABS) study [7••] was a 7-year study of weight change following Roux-en-Y and gastric banding. It was one of the few studies in which follow-up extended beyond 5 years. Most of the patients lost and maintained weight with little variability over the long term. They reported their results as total weight loss, and not %EWL. At 7 years, the mean weight loss with gastric bypass was 28.4%, with a mean weight regain of 3.9%. In addition, there was durable improvement in diabetes, hypertriglyceridemia, and hypertension following gastric bypass. Diabetes remission rates were 60.2% at 7 years [7••].

Finally, it is important to consider the patient's own definition of success, which may not be the same as the bariatric surgeon's. Although weight loss is the primary goal, every patient has his or her own reasons for losing weight. They each have a vision of what losing the excess weight would allow them to accomplish. This could include improved mobility, improved health, improved relationships, or improved self-esteem. These can be grouped together as an improvement in quality of life. Quality of life is personalized and individualized, and it is difficult to quantify, but it is important to consider. This discordance in the definitions of success can alter expectations and contribute to poor postoperative weight loss. The patient's expectation is that the surgery and weight loss will make them happier and more fulfilled. The same LABS study referenced above demonstrated significant improvement in mobility, back pain, and knee pain that begins within a year after surgery and is sustained for at least 3 years.

The Assessment of Bariatric Surgery Study (ABS Study) [7••] was designed to assess patients' perceptions as well as their decision-making process when it comes to weight loss surgery and how these factors affect quality of life and overall health. In the ABS Study, researchers interviewed patients considering weight loss surgery and found that patients'

expectations for weight loss surgery were not necessarily aligned with the reality of what bariatric surgery could offer. Patients believed that in order to gain any health benefits, they needed to lose large amounts of weight. Two-thirds of patients responded that they would be unhappy with an EWL% of 50%, although this is considered a successful outcome. Women as well as more affluent patients were also more likely to have higher weight loss expectations, whereas men and African Americans had lower weight loss expectation. This study was the first to document how patients place more value on weight loss than attaining better health. Patients were more willing to accept a higher mortality risk to achieve weight loss rather than to achieve better health. The study brings into question whether patients are adequately educated and prepared to make a decision on weight loss surgery. The study suggests that more frank discussions need to be had with patients regarding what to expect in terms of weight loss and comorbidity resolution post-surgery. [8]

The purpose of this paper is to review the factors thought to affect success after weight loss surgery. We know there are several factors involved in successful weight loss following bariatric surgery [9]. These include clinical, demographic, and behavioral variables, as well as preoperative, procedural, and postoperative factors. Identifying these predictors of success in advance will allow us to determine good versus poor surgical candidates. Additionally, we may be able to intervene on the modifiable risk factors and improve a patient's chances for success [10].

Demographic and Patient Factors Affecting Success with Bariatric Surgery

There exist several preoperative clinical and demographic factors that are associated with weight loss after bariatric surgery [11]. These include variables such as age, baseline BMI, the presence of comorbid conditions such as diabetes and hypertension, and the type of surgery performed [12••]. Demographic and patient factors include male gender, older age at time of surgery, single status, greater initial weight, higher initial BMI, presence of comorbidities such as diabetes, psychiatric disorders, poor follow-up, lower socioeconomic status and lower educational level, unemployment, and lack of social support [10, 11].

The clinical variable with the greatest effect on weight loss has consistently been shown to be the preoperative BMI, which has an inverse relationship with excess weight loss [13••, 14]. Several studies have shown that a higher starting BMI is associated with a lower percent excess weight loss. It stands to reason that those with the highest preoperative BMI also have the most to gain with weight loss in terms of medical conditions and quality of life. So why do these patients not fare as well is an enigma. Perhaps the underlying social factors

that lead to the obesity in the first place are challenges the patients have a difficult time overcoming. This remains an area of further investigation.

In 2012, Still et al. [15•] studied over 2000 consecutive patients undergoing gastric bypass over a period of 3 years and analyzed 350 variables and their effects on weight loss. Regression models were used to determine how each variable affected weight loss after accounting for baseline BMI. By studying the subjects over 3 years, they were able to demonstrate the three phases common to postoperative weight loss. These phases are the early rapid weight loss, followed by the nadir or lowest weight, and finally the long-term weight stabilization phase. In general, patients lose a majority of their weight within the first 18 months after bariatric surgery. After this point, they reach their nadir. Following the nadir is a period of weight stabilization, which can be characterized by some degree of weight regain. In their study, the mean maximum excess weight loss was 77%, and the long-term EWL greater than 3 years was 61%. The study confirmed that preoperative BMI is the best clinical predictor of early and late weight loss. This suggests around a 16% excess weight regain after 3 years. A BMI less than 40 was associated with 40% more excess weight loss as compared with a BMI above 60. Factors associated with worse weight loss included history of diabetes, age > 50, and liver fibrosis. Younger age has been shown in some studies to predict more weight loss as well [16]. The greater weight loss with younger age may be related to younger patients having less comorbidities as well as a shorter period of time with those comorbidities. Additionally, younger patients generally have more mobility that may allow them to be more active than older patients. Therefore, a younger patient would be expected to lose weight more efficiently without many metabolic comorbidities that hamper weight loss and mobility [17].

Sillen et al. [18•] identified similar predictors of poor weight loss after bypass surgery. These predictors of weight loss failure included early onset of obesity during childhood, higher initial BMI, and higher preoperative weight. This correlates with several other studies which found that higher BMI and higher preoperative weight were the best predictors of suboptimal weight loss.

Does the Procedure Predict Weight Loss after Surgery?

The type of bariatric surgery operation also has an effect on the amount of excess weight lost. Bariatric procedures are categorized broadly as restrictive, malabsorptive, or combined restrictive and malabsorptive procedures. Restrictive procedures reduce the size of the stomach and limit the amount of food that can be consumed. Malabsorptive procedures limit the amount of nutrients that are absorbed by bypassing a portion of the small bowel. The most common restrictive bariatric

procedures are sleeve gastrectomy and the adjustable gastric banding procedure. The Roux-en-Y gastric bypass is considered the gold standard of weight loss surgery. It is a combined restrictive and malabsorptive procedure. The biliopancreatic diversion with duodenal switch is considered primarily malabsorptive [19].

A systematic review and meta-analysis from 2017 compared the long-term (> 5 years) and midterm (3–5 years) outcomes of sleeve gastrectomy and Roux-en-Y bypass [20•]. Interestingly, both procedures had equivalent resolution of comorbidities and equivalent short- and midterm weight loss. Where they differed, however, were in long-term weight loss. The Roux-en-Y produced superior weight loss at 5 years. In terms of success, both procedures could be said to achieve similar results when it pertains to resolution of comorbidities, despite the difference in weight loss. Considering the higher complication and morbidity rate of the gastric bypass as compared to the sleeve gastrectomy, the sleeve gastrectomy may be a better choice in patients with multiple comorbidities.

In the 7-year follow-up LABS study, gastric bypass and gastric banding are compared. The weight loss with the bypass is greater with less recidivism. Comorbidity resolution was greatest with the bypass with a significant sustained improvement in diabetes. [7••] This demonstrates that the combined restrictive and malabsorptive procedure is more effective in amount of weight lost as well as improvement in comorbidities. Such a study comparing sleeve and gastric bypass needs to be done.

Since it is well-known that the different procedures are effective to varying degrees, how does one choose the correct weight loss procedure for the patient? This is a complex question, and the answer is not simple; otherwise, a clear algorithm would have been created by now. The decision begins with a detailed discussion between the patient and the surgeon regarding the patient's dietary weaknesses and health/weight loss goals. For patients in whom portion control is the primary concern, a sleeve gastrectomy may be the right tool. For those with a propensity for sweets or diabetes, the bypass may be preferred. The STAMPEDE trial is one of the best studies demonstrating a superiority of gastric bypass over sleeve for diabetes [21]. However, if you add in that a patient is diabetic and has COPD and congestive heart failure, then the shorter operative time of the sleeve gastrectomy might be more ideal. In the studies mentioned previously, the bypass has an advantage over the sleeve with weight loss so often is the preferred procedure. However, if the patient has health conditions that may increase morbidity or require a lower operative time, the sleeve may be preferred.

In the elderly, the sleeve gastrectomy has been shown to have less morbidity. If a patient is superobese, then a staged procedure may be considered with an initial sleeve gastrectomy followed by a gastric bypass if the BMI plateaus in the 40's postoperatively. When reaching BMI's over 60, the

bypass has a much higher complication rate. Choice of procedure is always a detailed discussion between the surgeon and patient to determine the best tool for that patient. There is no magic formula at this time to determine the best procedure for a patient; however, it is well established that the bypass is generally more effective than the sleeve for weight loss [22].

Psychological and Behavioral Factors

The long-term success of bariatric surgery, and any weight management program for that matter, requires adherence to dietary and behavioral changes. Sustained weight loss requires dedicated behavioral modifications to eating habits, as well as an increase in physical activity [23]. Like many areas of medicine, bariatric surgery suffers from poor patient compliance with these recommendations [24]. It is this patient compliance that contributes most strongly to the long-term success of bariatric surgery. Many obese patients come to surgery with poor eating habits and routines that have been engrained into their daily life over many decades. Maladaptive eating habits following surgery include grazing, eating calorie dense foods, binge eating, and consuming high calorie liquids. These can all negate the positive effects of weight loss of surgery. In many ways, bariatric surgery forces a behavioral change on the patient by restricting the calorie intake for at least a period of time. Bariatric surgery, through hormonal effects, can also decrease hunger and increase feelings of satiety. These factors can initially control maladaptive eating habits. However, if poor eating habits are allowed to reenter or if they were never controlled to begin with, they will derail the weight loss journey and lead to weight regain. A patient's ability to adhere to new lifestyle and eating habits is crucial to the success of surgery. Patients need to be willing and able to make a lifelong commitment to lifestyle changes and new habits. Gauging a patient's readiness and willingness to change is crucial. An adherence score might be an interesting concept to investigate to better predict the success of these patients. Currently no such scoring exists.

Binge eating disorder is a maladaptive eating habit that has specifically been associated with poor outcomes from bariatric surgery. Binge eating is defined as eating larger than normal amounts of food for 2 or more days a week over a 6-month period. Patients with binge eating disorder tend to have other associated psychiatric disorders such as depression, anxiety, or personality disorders. The binge eating disorder is characterized by a loss of control, and it is this loss of control that ultimately translates into poor postoperative weight loss. Binge eating interferes with the behavioral changes necessary for bariatric surgery to work successfully [25]. Binge eating disorder is prevalent in the bariatric patient population, with up to 50% of patients suffering from the disorder [26].

The restrictive aspect of bariatric surgeries makes it impossible to binge eat, at least initially. The loss of control aspect of binge eating, however, remains [27]. One of the behaviors patients with binge eating disorder may adopt in the postoperative period to overcome the restrictive aspect of the operation is grazing. When grazing, patients eat several small, frequent meals throughout the day. In some cases, these can be high calorie liquids that pass and get absorbed quickly, allowing the patient to continue to consume a large number of calories. Colles et al. [28] showed that up to 60% of patients with binge eating disorder develop this compensatory grazing postoperatively. Some of the postoperative difficulties patients have such as postprandial vomiting, dumping syndrome, reflux, or abdominal pains can signify a patient's noncompliance with postoperative diet recommendations.

Emotional eating is another maladaptive eating behavior that interferes with weight loss. Some bariatric patients report a history of eating as a way to cope with emotional distress [29]. The pleasure derived from eating is one of the most primal and basic pleasures of the human brain. Eating triggers areas of the brain associated with pleasure and in turn releases neurotransmitters that make a patient feel happy [30]. It is unfortunate, but as many as 30% of patients undergoing weight loss surgery have suffered some sort of abuse in their history. It is very important that these issues are addressed and the patient finds another stress reliever other than eating to improve their postoperative outcome. On a positive note, studies have shown that losing weight can have a positive effect on patient's emotions and curtail the desire to eat in response to emotions. In preparation for weight loss surgery, patients are highly encouraged to identify a stress relief mechanism besides eating to prepare for these situations after surgery.

All bariatric surgery programs and major insurance companies require preoperative psychological evaluation prior to bariatric surgery. The purpose of this evaluation is to identify pre-existing mental disorders and eating behaviors that may contribute to poor surgical outcome and that can be intervened on to help patients achieve optimal results. The parts of this psychiatric evaluation may include a mental health history, current mental health diagnoses and treatments, past and current substance abuse history, and history of suicide attempts. Some programs use other diagnostic questionnaires to identify personality disorders and maladaptive eating habits [31••]. This pre-surgical assessment can identify patients with mental disorders and other barriers to weight loss. By identifying these patients, more pre- and postoperative interventions can be directed at them. The ultimate objective of these assessments is to improve surgical outcomes. Identifying current stressors as well as social support is also important and contributes to postoperative weight loss.

In addition to conducting a clinical interview, many practices utilize psychometric testing to identify personality traits and psychiatric problems in preoperative patients [32].

Psychometric testing involves using questionnaires to assess a patient. The psychometric testing may help identify personality traits and eating behaviors that may not be easily obtained during the clinical interview. As a professional association, the ASMBS does not endorse any single screening tool and leaves it up to the psychological evaluator to decide which tool is best to use based on the available literature. One of the screening tools that has been written about is the EDE-BSV or Eating Disorder Examination-Bariatric Surgery Version used by the LABS study to evaluate patients for eating disorders both preoperatively and postoperatively. Interestingly they identified that the presence of preoperative eating disorder did not influence weight loss and that these disordered eating behaviors actually improved postoperatively. However the presence of continued eating disorders after surgery was found to decrease postoperative weight loss [8].

Preoperative weight loss is another predictor of postoperative weight loss [33]. Most bariatric surgery centers require their patients to lose a set amount of weight before accepting a patient for bariatric surgery. This can vary from a percentage of weight to a set number of pounds. The preoperative weight loss aids in shrinking the liver, making the surgery easier. An additional effect, however, is to serve as a test of a patient's ability to change habits. Those patients who lost at least 10% of their excess weight preoperatively were twice as likely to have a 70% EWL after surgery [34••]. This finding indicates that those patients who demonstrate the ability to comply with strict behavior changes also have the ability to carry through with the behavior changes that bariatric surgery requires in order to be successful.

Ideally an adherence measure will be helpful as a part of the workup but does not exist at this time. As the provider, you can sometimes get a sense of which patients are doing to do well with surgery, but many patients will pleasantly surprise you. The improvement in quality of life is a significant motivator for success. The behavioral component of weight loss is an area that requires further study. Most programs provide ongoing behavioral support for patients in the form of support groups. This is very helpful to patients.

Role of Depression and Anxiety

Depression and anxiety disorders are prevalent in the obese population [35]. Their effect on weight loss post-bariatric surgery, however, is unclear and controversial. Some studies show no effect of mental illness on weight loss, but the results are inconsistent. Between 20 and 60% of bariatric patients have an active psychiatric disorder, with the most common being depression and anxiety. The lifetime risk of a psychiatric disorder in obese patients is over 70% [36]. Scholtz et al. [37] found that bariatric patients with a psychiatric disorder at the time of surgery did not differ from patients without a psychiatric disorder in terms of surgical outcome. Other studies, on

the other hand, demonstrate a negative effect of depression, but not of anxiety, on postoperative weight loss [38]. Additionally, studies show a significant improvement in depression, but not in anxiety, postoperatively [39]. This improvement in depression can lead to improvement in weight loss. Depression has been shown to lead to an unhealthy lifestyle, decreased physical activity, and poor eating habits that result in less weight loss and even weight gain postoperatively. General consensus is that depression is improved by bariatric surgery and that patients ultimately derive an improvement in quality of life.

Studies have demonstrated that having more than one psychiatric illness compounds the negative effect on weight loss [40]. The persistence of these psychiatric disorders postoperatively synergistically adds to the poor weight loss. The presence of a psychiatric disorder also increases the likelihood that a patient will undergo reversal of their bariatric surgery [37]. Another interesting finding comes from Herpertz et al. [41] suggesting that mild depression, low self-esteem, or poor body image may actually have a positive effect on weight loss. They suggest that the presence of these factors aid in bringing about behavioral change and motivation that lead to increased weight loss.

A review of psychological predictors from 2014 further acknowledged the inconsistencies in the research with respect to the effects of psychological factors on weight loss [42]. It is found that personality and maladaptive eating behaviors could predict weight loss. The paper acknowledges bariatric surgery as a “stepping stone” and that the real core of weight loss comes about through lifestyle changes helped along by the surgery. Patient's that are unable to adjust to these changes risk compromising the entire effect of the surgery [9].

It is worth looking at what can be done preoperatively to optimize a patient prior to undergoing bariatric surgery. The first step is identifying a patient's weaknesses coming into the weight loss process, whether this be binge eating, depression, loss of control, or anxiety. By identifying the problem areas, these areas can be more easily addressed through lifestyle modifications, education, and coaching [43]. It is also important to continually pay attention to and rescreen for these problem areas postoperatively and offer support in the form of counseling and support groups for bariatric patients.

Cognitive behavioral therapy (CBT) has shown some effect on correcting maladaptive eating patterns bariatric surgery patients bring with them [44]. The course of CBT treatment gradually addresses particular aspects of the eating disorder and makes behavioral adjustments over weeks by teaching new coping skills. These interventions include cognitive restructuring, body image processing, stress management, relaxation techniques, stimulus control, and eating pattern regulation. In addition they include some group discussions on managing social situations and what to expect after bariatric surgery. The patients enrolled in CBT training lost

significantly more weight than their counterparts at both 6- and 12-month follow-up, with gastric bypass patients who underwent CBT having 68% EWL vs 54% EWL in the non-CBT group [43].

Ogden et al. [45] investigated the effects of a bariatric rehabilitation services on weight loss. The services involved three 50-min sessions with a health psychologist, who provided support and mentoring to address psychological issues such as dietary control, self-esteem, coping, and emotional eating. They assessed weight loss at 1 year and showed no effect on weight loss through the intervention. The study, however, is limited by only a 1-year follow-up period. The lack of difference in outcomes at 1 year indicates that the surgical effects on weight loss are fairly robust initially and likely continue for the first 18 months. Longer-term follow-up is needed to assess the real effect of behavioral therapy on weight loss, especially at a time when the surgical effect of the procedure has gone away. Psychological support directed at later follow-up may be more effective. Further long-term studies looking at outcomes 3 years or more are needed. Laying initial foundations of good eating habits and then reinforcing them over the years could have a positive effect on long-term weight loss.

Patients who require repeat bariatric surgery provide useful insights. Inadequate weight loss is the most common indication for reoperation after excluding surgical complication related reoperations. Rates of reoperation can be as high as 30% in gastric banding patients, but sleeve gastrectomy and bypass patients also undergo revisions [12••]. Reoperative procedures are technically challenging and have higher complication rates than primary surgeries and therefore should be pursued only when absolutely necessary. Pinto-Bastos et al. [46•] investigated a group of reoperative patients to determine predictors of success. Reoperative patients reported more binge eating episodes per week than primary surgery patients. The two groups did not differ in their rates of depression or anxiety. This study suggests that reoperative patients present more maladaptive eating behaviors as the predictor of their failure.

Socioeconomic Factors

Morbid obesity appears to disproportionately affect economically disadvantaged patients and racial minorities. It appears that the population most affected by obesity is the population that least often utilizes bariatric surgery, as a 2006 analysis of the Nationwide Inpatient Sample demonstrated that lower income, non-privately insured, and minority status were all predictors of lower utilization of bariatric surgery [47].

Not only are there differences in utilization of bariatric surgery across a variety of socioeconomic and racial factors, but outcomes can be affected by these factors as well. The differences in outcomes actually start in the immediate postoperative period, as mortality rates have been demonstrated to be higher among certain populations. Another survey of the Nationwide Inpatient Sample demonstrated higher in-hospital mortality for non-Hispanic blacks compared to non-Hispanic whites. Furthermore, predictors of mortality in this study on multivariate analysis included non-Hispanic black race and Medicare or Medicaid insurance, among others [48].

Long-term outcomes have been demonstrated to be affected by ethnicity or race. A single-center study of patients undergoing bariatric surgery demonstrated that Caucasian ethnicity was a predictor of weight loss at 2 years [49]. A larger meta-analysis of 1087 African American patients and 2714 Caucasian patients examined differences in excess weight loss between these groups. Weight loss was noted to be significantly more in Caucasian patients, with about 8.36% more excess weight loss. This result held true regardless of whether a restrictive or malabsorptive procedure was performed. Of note, resolution of diabetes was about the same between groups [50]. Racial disparities have been noted in several studies; however, the reasons for these differences are unclear.

Socioeconomic status also appears to play a significant role in weight loss after bariatric surgery. Issues with access to care and poor preoperative education play a role in success in terms of weight loss after bariatric surgery. In a study of 127 patients being evaluated for bariatric surgery, patients were administered an objective assessment of knowledge of obesity and bariatric surgery. Patients were asked about income, formal education, employment status, height, and weight. The study found that higher income was the sole predictor of high score on the objective assessment, indicating an opportunity for increased education for low-income patients [51]. With dietary and lifestyle modification being an essential part of success after bariatric surgery, it is important to recognize the role of preoperative education in the patient's postoperative success. An additional study examined socioeconomic factors as predictors of weight loss in bariatric surgery patients at a single institution and found that patients with lower schooling tended to lose less excess weight after surgery [52]. This may be related to less understanding of nutrition and how to make appropriate food choices.

The reason behind why African Americans and low income patients have poorer weight loss outcomes remains unknown. The etiology is likely multifactorial. Although differences in meal composition had been thought to be a factor in postoperative weight loss, studies have demonstrated that meal composition is not a factor in postoperative weight loss [53, 54]. In the USA, African Americans tend to have a background of lower socioeconomic status than Caucasians [55].

A recent study of the National Health and Nutrition Examination Survey demonstrated that adults earning less than \$20,000 per year were 50% less likely to use strategies consistent with recommendations to lose weight [56].

Conclusion

Weight loss following bariatric surgery is complex and relies on several factors. Identifying potential indicators of surgical success enables better patient selection and development of pre- and postoperative interventions that can heighten the effectiveness of bariatric surgery. After the immediate surgical effect abates, long-term sustained weight loss depends on the patient's ability to adopt healthy eating habits and lifestyle changes. Maladaptive eating patterns have been shown to be predictive of postoperative weight loss. Binge eating disorder in particular has a strong negative effect. On the other hand, the effects of postsurgical depression and anxiety on weight loss remain inconclusive. Going forward more attention needs to be directed at correcting and redirecting maladaptive eating habits. This needs to be stressed preoperatively, postoperatively, and even years after surgery in order to have long-term success.

The combined malabsorptive/restrictive procedure, RYGBP, remains the gold standard weight loss operation and has withstood the test of time. The complications are well-known and can be easily mitigated with early recognition. The durability of this procedure has been established. The other procedures continue to be followed, and time will determine their durability.

The treatment of morbid obesity needs a multidisciplinary team approach. The surgeon, psychiatrist, psychologist, counselor, nutritionist, bariatric navigator, and even the primary care physician all play a vital role in the patient's journey. All need to be aware of the barriers to weight loss specific to a particular patient and be able to address those barriers. Whatever the reason for limited success after bariatric surgery, it is important to recognize populations of patients at risk for less excess weight loss after surgery, so that measures can be taken from the initial preoperative period to ensure that patients are successful. An adherence score may be a helpful predictor in the future.

Compliance with Ethical Standards

Conflict of Interest Stephen Masnyj, Brian Shea, and Leena Khaitan declare that they have no conflict of interests pertinent to the paper.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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