

Behavioral Predictors of Weight Regain after Bariatric Surgery

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Abstract

Background After bariatric surgery, a lifelong threat of weight regain remains. Behavior influences are believed to play a modulating role in this problem. Accordingly, we sought to identify these predictors in patients with extreme obesity after Roux-en-Y gastric bypass (RYGB).

Methods In a large tertiary hospital with an established bariatric program, including a multidisciplinary outpatient center specializing in bariatric medicine, with two bariatric surgeons, we mailed a survey to 1,117 patients after RYGB. Of these, 203 (24.8%) were completed, returned, and suitable for analysis. Respondents were excluded if they were less than 1 year after RYGB. Baseline demographic history, preoperative Beck Depression Inventory (BDI), and Brief Symptom Inventory-18 scores were abstracted from the subjects' medical records; pre- and postoperative well-being scores were compared.

Results Of the study population, mean age was 50.6 ± 9.8 years, 147 (85%) were female, and 42 (18%) were male. Preoperative weight was 134.1 ± 23.6 kg (295 ± 52 lb) and 170.0 ± 29.1 kg (374.0 ± 64.0 lb) for females and males, respectively, $p < 0.0001$. The mean follow-up after bariatric surgery was 28.1 ± 18.9 months. Overall, the mean pre- versus postopera-

tive well-being scores improved from 3.7 to 4.2, on a five-point Likert scale, $p = 0.001$. A total of 160 of the 203 respondents (79%) reported some weight regain from the nadir. Of those who reported weight regain, 30 (15%) experienced significant regain defined as an increase of $\geq 15\%$ from the nadir. Independent predictors of significant weight regain were increased food urges (odds ratios (OR) = 5.10, 95% CI 1.83–14.29, $p = 0.002$), severely decreased postoperative well-being (OR = 21.5, 95% CI 2.50–183.10, $p < 0.0001$), and concerns over alcohol or drug use (OR = 12.74, 95% CI 1.73–93.80, $p = 0.01$). Higher BDI scores were associated with lesser risk of significant weight regain (OR = 0.94 for each unit increase, 95% CI 0.91–0.98, $p = 0.001$). Subjects who engaged in self-monitoring were less likely to regain any weight following bariatric surgery (OR = 0.54, 95% CI 0.30–0.98, $p = 0.01$). Although the frequency of postoperative follow-up visits was inversely related to weight regain, this variable was not statistically significant in the multivariate model.

Conclusions Predictors of significant postoperative weight regain after bariatric surgery include indicators of baseline increased food urges, decreased well-being, and concerns over addictive behaviors. Postoperative self-monitoring behaviors are strongly associated with freedom from regain. These data suggest that weight regain can be anticipated, in part, during the preoperative evaluation and potentially reduced with self-monitoring strategies after RYGB.

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Introduction

Bariatric surgery has been used to treat obesity for over 50 years [1]. The prevalence of obesity is rising at an

alarming rate, and escalating numbers of patients are turning to bariatric surgery as an effective treatment option for the resolution of morbid obesity [2]. Additionally, substantial numbers of patients with hypertension, diabetes, hyperlipidemia, and obstructive sleep apnea experience improvement or even complete resolution of these conditions after surgery [3]. Bariatric surgery is an intervention that may mislead patients by creating the perception that a transient weight loss will automatically be permanent. Patients may rely on the surgical procedure to “cure their obesity” and falsely believe that it will inherently bring about the necessary behavioral changes to sustain weight loss and reduce mortality [4]. This belief may further serve to heighten the risk of weight regain.

To achieve and maintain optimal weight loss after bariatric surgery, concomitant lifestyle changes are critical. These include nutritional optimization, a commitment to regular structured exercise, increased lifestyle physical activity, stress management, realistic goal setting, environmental control strategies, support systems, and cognitive restructuring [4–13]. Some of the greatest challenges for weight-loss surgery patients may stem from failure to embrace these lifestyle changes [12, 13]. Behavioral influences and life stressors have traditionally been thought to play a role in postoperative patient success. Accordingly, it is important to understand the factors that influence weight regain after bariatric surgery, so that it can be minimized or prevented. The present study was conducted to better understand the influence of behaviors on postoperative weight regain.

Methods

A mail survey was used to collect data and assess behavioral characteristics in postbariatric surgery patients. The survey included a self-reported well-being instrument, developed for this study, which consisted of a Likert scale of ratings 1 (poor) to 5 (good). This scale was administered at entry into our program and again during the postoperative survey. The survey contained questions about sources of postoperative stress and related behaviors, including control over food urges in a yes/no format.

Patients who had bariatric surgery after the inception of our surgical treatment program in 2001 were identified through the William Beaumont Hospital Weight Control Center patient database. Surveys were mailed to 1,117 patients. A total of 278 surveys (24.8%) were returned; of these, 233 had completed all entry data. Patients that were less than 1-year postoperative ($n=30$) were excluded, leaving 203 subjects for the final analysis in order to identify a group of patients with sufficient time to have incurred weight regain [4]. Gender, age, pre- and postoperative well-being data, Beck Depression Inventory (BDI) scores, Brief Symptom Inventory-18 (BSI-18) scores, and

the presence of baseline medical conditions were extracted from the subjects’ medical records. Amount of weight regain, if any, was self-reported on the survey from the nadir weight recorded in the center. Informed consent was obtained, and approval from the William Beaumont Hospital Human Investigations Committee was granted.

Statistical Analysis

All continuous and categorical predictors were first assessed using numerical and graphical techniques to determine if they met the distributional assumptions of the statistical tests used to analyze them. Based on this preliminary assessment, parametric, nonparametric, and exact statistical tests were used in the analysis. Continuous variables were summarized using mean \pm standard deviation; categorical variables were summarized using counts and percentages. Dichotomous variables were then compared individually to the outcome using the two-tailed Fisher’s exact test. Variables that were statistically significant with respect to the outcome were then analyzed using stepwise multiple logistic regression analysis to determine the most parsimonious subset of predictors. The adjusted odds ratios (OR) and their corresponding Wald 95% confidence intervals were calculated. p values of ≤ 0.05 (probability of type I error) were considered statistically significant. Statistical analysis was performed using The SAS System for Windows version 9.1.3, Service Pak 2.

Results

The mean subject age for the 203 respondents was 50.6 ± 9.8 years; 147 (85%) were female. Preoperative weight was 134.1 ± 23.6 kg (295 ± 52 lb) and 170.0 ± 29.1 kg (374 ± 64 lb) for women and men, respectively ($p < 0.0001$). Preoperative body mass index for women was 48.8 ± 7.6 and 53.9 ± 9.1 kg/m² for men. Additional baseline characteristics are reported in Table 1. The mean follow-up after bariatric surgery was 28.1 ± 18.9 months. Mean well-being scores of the study population improved from 3.7 before surgery to 4.2 afterward ($p = 0.001$). Of note, the vast majority, $>90\%$, of respondents reported that no one else had expressed concern about their alcohol use. Twenty five (9.1%) of the respondents identified increase alcohol use, 53 (19.1%) reported a decrease of alcohol use, 83 (30.1%) reported no change in their pattern of alcohol use, and 115 (41.7%) never used alcohol. Of the 203 subjects who were included in the analysis, 160 (79%) reported weight regain. Of those who reported weight regain, 30 (15%) regained $\geq 15\%$ of total weight lost, which we defined as “significant weight regain”.

Table 1 Baseline preoperative characteristics by degree of weight regain after bariatric surgery with Roux-en-Y gastric bypass

Baseline characteristic	No weight regain (<i>n</i> =43)	Weight regain* (<i>n</i> =160)	<i>p</i> value	Significant weight regain* (<i>n</i> =30)	<i>p</i> value (vs. all other patients)	For all patients (<i>n</i> =203)
Age (years)	50±12.0	50.9±9.2	0.98	49±10.8	0.67	50.6±9.8
Female	32 (18.6%)	115 (66.9%)	1.00	19 (11.1%)	0.75	147 (72.4)
Caucasian	34 (21.5%)	111 (70.3%)	0.73	20 (12.7%)	1.00	146 (71.9)
African American	2 (1.3%)	11 (7.0%)		1 (0.6%)		13 (6.4)
BMI (kg/m ²)	50.8±9.3	48.4±7.3	0.27	47.1±5.1	0.52	48.9±7.8
Diabetes	15 (9.4%)	57 (35.9%)	0.71	6 (3.8%)	0.11	73 (36.0)
Hypertension	25 (15.7%)	80 (50.3%)	0.69	11 (6.9%)	0.22	106 (52.2)
Tobacco use	4 (2.6%)	5 (3.2%)	0.21	0	0.61	9 (4.4)
BDI (Beck Depression Inventory)	24.8±18.7	21.4±18.5	0.16	13.6±13.8	0.012	21.3±18.5
BSI-18 (Brief Symptom Inventory-18)	33.5±21.8	36.4±22.8	0.52	42.9±20.4	0.25	35.9±22.5

Continuous variables are summarized using mean ± standard deviation

^a The population numbers reported in the significant weight regain column are included in the *n* of the weight regain column

Predictors of Weight Maintenance

Regression analysis identified behavioral changes that were the most influential factors in weight maintenance (no weight regain). Independent predictors of weight maintenance included control over food urges (OR=0.38, 95% CI 0.21–0.71, $p<0.0001$), improved control over their eating habits (OR=0.29, 95% CI 0.08–1.02), and engagement in self-monitoring (weighing regularly and keeping records; OR=0.54, 95% CI 0.30–0.98, $p=0.01$). In contrast, there was no relationship between weight maintenance and baseline BSI or self-reported postoperative perceived stress (family, social, work, financial, or health), postoperative quality of sleep, or baseline characteristics, including gender, tobacco use, race, and presence of diabetes mellitus or hypertension.

Predictors of Significant Weight Regain

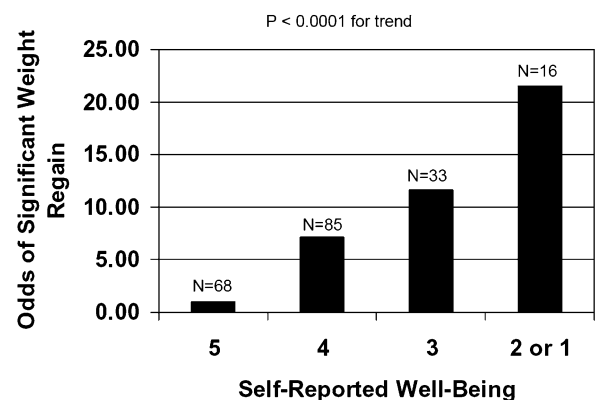
Independent predictors of significant weight regain were lack of control food urges (OR=5.10, 95% CI 1.83–14.29, $p=0.002$) and concerns over alcohol or drug use (OR=12.74, 95% CI 1.73–93.80, $p=0.01$). Higher BDI scores were associated with lesser risk of significant weight regain (OR=0.94 for each unit increase, 95% CI 0.91–0.98, $p=0.001$). Poor postoperative well-being was inversely related to weight regain. Patients with the lowest self-reported well-being scores (1 or 2 out of 5) were 21.5 times as likely to experience significant weight regain as compared with those self-reporting good well-being (5), after adjusting for BDI and food urges (OR=21.5, 95% CI=2.50–183.10, $p<0.0001$). Patients with self-reported mid-range of well-being of 3 out of 5 also had an elevated adjusted risk of significant weight regain (OR=11.6, 95% CI=2.10–63.60, $p=0.01$). Finally, a self-reported well-being of 4 out of 5 had an adjusted and still elevated OR of 7.10

(95% CI 1.40–35.0, $p=0.02$) for significant weight regain when a score of 5 of 5 was set as the referent (Fig. 1).

Patients with no follow-up visits were 4.6 times more likely to regain weight as those who attended four to five follow-up clinic visits per year (OR=2.60, 95% CI 1.8 11.7, $p=0.001$). Although the frequency of return visits was statistically significant when univariately compared with this outcome, it did not remain so once food urges were factored in the multiple logistic regression model ($p=0.06$ for no visits, $p=0.36$ for annual visits, and $p=0.10$ for two to three visits or more per year).

Discussion

Weight regain after bariatric surgery is commonly observed and can reasonably be predicted via selected behavioral



Adjusted for baseline Beck Depression Inventory and the presence of food urges, significant weight regain defined as ≥ 15% increase in weight from post-operative nadir

Fig. 1 Adjusted odds of significant weight regain according to postoperative self-assessment of well-being on a five-point Likert scale (*n*=1 missing)

factors in patients willing to complete a survey. We demonstrated that lack of control over food urges, concerns regarding addictive behaviors, decreased overall postoperative well-being, lack of self-monitoring, and fewer postoperative follow-up visits are associated with weight regain. Conversely, excellent self-reported well-being (5 out of 5) and self-monitoring predicted freedom from significant regain. We defined our primary outcomes as no weight regain, any weight regain (1–15%), and significant weight regain (>15%). We distinguished 15% weight regain as an outcome measure because weight regain less than this level is commonly described in the postoperative population [14].

We observed greater weight regain in participants with specific behavioral profiles. Studies have shown that behavioral treatment is effective in non-surgical and surgical weight-loss management because it tailors therapy to the specific concerns and behavioral patterns of patients [10, 12]. Few data are available regarding behavioral or psychological predictors of weight-loss outcomes after bariatric surgery [15]. The identification of such predictors is of great interest to physicians and healthcare providers working with the morbidly obese to improve patient screening, counseling, and assistance with targeted treatment or management algorithms. Our data substantiate the idea that coupling weight-loss surgery with behavioral interventions, similar to what is used for traditional weight control patients, may help to prevent weight regain.

Depression

The association between presurgical depression and weight changes following gastric bypass surgery is not completely understood. Our study utilized the BDI score prior to weight-loss surgery and demonstrated an inverse relation between the BDI and the risk of significant weight regain postoperatively. Specifically, we found that the lower the preoperative depression score, the more likely people were to experience weight regain. We can speculate that the symptoms of high levels of depression, as measured by the preoperative BDI, may be reduced by weight loss and health improvements. These benefits may serve to effectively promote weight maintenance. In our center, we provide more intensive psychosocial and psychopharmacological intervention for those patients with high preoperative depression levels, which could promote greater patient success in preventing weight regain. We can also hypothesize that those with higher preoperative depression levels have a greater sense of urgency and desperation for symptom relief, which could impact their commitment to continued effort to maintain weight in order to sustain an improved quality of life.

Previous studies have shown a correlation between BDI score improvements with surgery and weight-loss outcome [5]. In a study of psychosocial predictors of weight loss

after bariatric surgery, investigators reported less successful outcomes for those with psychiatric derangements (particularly adjustment disorders, depression, and or personality disorders) as compared with their counterparts without these conditions [16]. Our findings are in direct contrast to these results since we found that higher preoperative depression levels were associated with smaller weight gains after bariatric surgery. It is likely that depressive symptoms are dynamic, and since we did not repeat the BDI in the postoperative time period, we cannot draw conclusions concerning concurrent depression and weight regain.

Alcohol Use

There is emerging interest in understanding the risks for alcoholism or substance abuse among bariatric surgery patients. The interest and concern stems from the concept of addiction swapping or “addiction transfer”, where food may be replaced by an alternate substance as a coping strategy. In our study, we surveyed postoperative alcohol consumption patterns and queried if anyone expressed concern about the individual’s alcohol or substance use. We found statistical significance only in respect to concern expressed by others and weight regain. Of note, we did not identify preoperative alcohol use, and therefore, high levels of alcohol use could have remained unchanged postoperatively, and these individuals would have been missed.

Bariatric patients may be more sensitive to alcohol because the digestive alterations promote augmented and rapid absorption of alcohol into the bloodstream, which may facilitate alcohol addiction. In addition to addiction concerns, optimal weight-loss goals may not be met with increased alcohol use due to the dense caloric composition of alcoholic beverages. A prior study found that increased alcohol sensitivity was reported in 90% of RYGB patients and 63% of those reported feeling the alcohol effects within a few sips of the beverage [17]. Given these concerns, most surgical programs advocate extreme caution and general abstinence from alcohol [18].

Well-Being

Patients in this study were asked on a Likert scale to rate their overall well-being before and after surgery. Because this rating encompasses all aspects of social, psychological, and physical health, we used it as a surrogate for “quality of life”. It is important to emphasize that preoperative scores were not predictive of weight outcome; however, postoperative well-being scores were inversely correlated with significant weight regain. Those with the lowest postoperative well-being scores (1 or 2) had markedly increased risk of significant weight regain as compared with those who scored highest (5). We cannot infer the direction of causality in this association since weight regain may be a determinant of decreased well-being

given the usually high patient expectations concerning reductions in adiposity after surgery. On the other hand, studies have demonstrated that a dramatic reduction in weight was associated with marked improvements in health, symptoms of depression, self-esteem, maladaptive eating behaviors, and overall quality of life [19].

Food Urges

We found that postoperative control over food urges was associated with weight maintenance. The ability to manage food urges appropriately has been previously reported as a predictor for successful weight loss and maintenance [20]. Some of this benefit may be attributed to the surgery itself since RYGB typically evokes an array of mechanical and physiological alterations that may favorably modify eating behaviors and reduce food urges. As a result, most patients report early satiety with smaller meals and decreased food urges. Nevertheless, varied postoperative appetite and eating urges are observed in this population. These may be modulated by psychological and environmental factors rather than physiological hunger per se. These findings suggest that medical providers, dietitians, and psychologists should ask postoperative patients about food urges and their ability to manage them. Future interventional research is needed to identify optimal medical, dietary, and psychological strategies to best handle food urges as this appears to be a key to the maintenance of weight loss after RYGB.

Participation with the Multidisciplinary Program

Less significant weight regain (<15%) was inversely associated with the number of follow-up visits in our multidisciplinary center (physician, psychologist, dietician, exercise physiologist, group education). Patients are encouraged to maintain bi-monthly support group attendance as well as periodic contact with our physicians, dietitians, and exercise physiologists. Poor patient adherence with behavioral recommendations is commonly reported following bariatric surgery, with suboptimal compliance to exercise and recommended dietary changes [19]. Other research has demonstrated that failure to attend postoperative appointments correlates with a diminished weight loss and more postoperative complications [5, 21–23]. Ongoing lifestyle education is critical to achieve weight loss and maintenance after bariatric surgery. Some have suggested that if basic nutritional and lifestyle instructions are not reinforced shortly after bariatric surgery, weight outcomes will be compromised [16]. This underscores the need for continued participation in follow-up, education, and support for this escalating patient population. The risk of weight regain likely diminishes with regular postoperative follow-ups, most likely owing to the persistence of dietary and physical activity behavioral changes [24].

Self-monitoring

We demonstrated that self-monitoring is an established cornerstone for the maintenance of weight loss [9]. Behavioral approaches to weight loss focus on changing the environment to modulate stimuli while reinforcing healthy eating and exercise habits. Self-monitoring of food, drink, exercise and weight is integral to behavioral weight management, heightening self-awareness of these parameters [9]. Keeping food records and regular weigh-ins are two commonly utilized styles of self-monitoring. Other key components of self-monitoring include goal setting, visualization, environmental control techniques, cognitive strategies, limit setting, recognizing social stimuli, positive social support, and celebrating successes [25]. Collectively, these strategies are critically important in helping patients prevent weight regain.

Study Limitations

Our study has limitations common in small, survey-based evaluations in patients undergoing ongoing medical care in the community. The study sample was biased because we evaluated only those who returned the survey. The focus of this investigation was on those who responded to the survey, and therefore, we did not study the group of non-responders. In all likelihood, non-responders may have had even poorer outcomes (e.g., greater weight regain) than responders. Because we relied on data from survey respondents only, our findings may not be generalizable to the entire postoperative population. However, considering the inherent selection bias observed, our data suggest that requesting disclosure from patients concerning the factors we assessed could be useful in clinical practice and future research, particularly in prospective studies with less opportunity for issues influencing participation once the surgery has been completed.

The non-standardized survey instrument we developed did not undergo internal and external validation processes as standardized tests such as the BDI and BSI-18 but used a simple and practical five-point Likert scale. Additionally, data were obtained using self-reported weight and eating behaviors, which are known to be potentially inaccurate and biased and, thus, this is a significant limitation [26]. Since this study included some patients who kept short-term or no follow-up in our center, we did not have the measured weights at the time the survey was completed. Finally, the suboptimal response rate to our survey represents a major study limitation. This may have biased the multiple logistic regression model that we employed in that components left unanswered eliminated the subject from the analysis. Despite these limitations, our findings are unique and provocative and suggest that behavioral factors play an important role in the long-term outcomes of patients undergoing bariatric surgery.

Conclusion

We identified behavioral predictors for weight regain in postoperative RYGB patients, which include increased food urges, concerns regarding addictive behaviors, decreased

well-being, fewer postoperative follow-up visits, and lack of self-monitoring. Additional behavioral research is needed in order to optimize weight outcomes in the bariatric surgery population.

Appendix

BARIATRIC SURGERY POST-OP SURVEY

1. Today's Date / /
mm dd yyyy
2. Surgery date / /
mm dd yyyy
3. Pre-operative weight lbs (day of surgery)
4. Current weight lbs
5. Lowest weight since surgery lbs
6. Are you still losing weight?
 Yes
 No
7. Have you regained weight since surgery?
 Yes
 No *please skip to question 8*
- 7a. Amount of regain from your lowest point:
 Enter exact amount lbs
- 7b. After surgery, when did you begin to regain?
 Give exact time in months months
8. Do you feel you are currently under a lot of stress?
 Yes
 No *Please skip to question 9*
- 8a. If yes, what is the source? *Please check all sources of stress*
 Family Financial
 Social Health
 Work

9. Has your alcohol consumption increased/decreased since bariatric surgery?

- Increased No change
 Decreased I never drank alcohol before or after

10. Has anyone ever expressed concern about your use of alcohol or drugs?

- Yes
 No

If yes, please describe: _____

11. Please rate your overall well-being at the present time: This includes physical, psychological, emotional, vocational, etc.

Please circle one

Poor 1 2 3 4 5 Good

12. Please check any behavior changes since surgery:

- More control over eating....can stop with less food
 Pre-planning food intake
 Self-monitoring (weighing regularly and keeping records)
 Improved sleep
 Set limits/boundaries around eating trigger foods
 Decreased food urges
 Feelings of hopelessness

13. Since your surgery date, how often do you visit the Weight Control Center?

- Not at all 2-3 times/yr.
 Once a year 4-5 times/yr.

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