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Determinants of Unhealthy Behaviors following Bariatric Surgery

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Abstract

Objective: To determine whether any psychological or emotional factors observed prior to bariatric surgery can predict poor adjustment or compliance in follow-up.

Study design: We linked information on pre-operative questionnaires and a psychological examination to observational data from medical staff of 86 patients in follow-up visits after gastric bypass surgery. We used Bayesian and classical statistical techniques to identify pre-operative variables that had potential statistical relationships with unhealthy behavior post-surgery and evaluated which were the strongest predictors through logistic regression.

Results: We identified five factors that potentially determine poor adjustment or compliance in our sample. Scoring high on the Weight Efficacy Life Style Questionnaire Total Scale or the Social Pressure subscale were positively related to poor adjustment. Low scores on the Multidimensional Body-Self Relations Questionnaire-Appearance Orientation scale and high scores on the Emotional Eating Scale-Depressive Mood subscale were associated with increased likelihood of complications. The latter proves the most durable, robust result and suggests a one-standard deviation higher pre-surgery difference predicts at least a 10 percent increase in the likelihood of showing signs of complications. Finally, one unexpected result emerged. A history of physical and sexual abuse was associated with fewer unhealthy behaviors following bariatric surgery.

Conclusion: Patients who eat when depressed were highly likely to experience complications post-bariatric surgery. No other pre-surgery factor emerged as important.

Introduction

In the U.S., obesity rates have more than doubled since 1980, from 15% to 30% in 2008 [1] and obesity is one of the most serious public health challenges the nation faces [2]. Obesity is strongly associated with increased risk of morbidity and mortality [3,4], and accounts for more than 21% of U.S. health care costs [5].

Bariatric surgery has been considered an effective tool for treating severe obesity [6,7]. In the U.S., the number of bariatric surgeries has increased tenfold since the mid-1990s, with approximately 180,000 operations performed in 2013 [8]. According to the National Institutes of Health [9], individuals may be candidates based on the following criteria: patients with clinically severe obesity (Body Mass Index (BMI) ≥ 40), or a BMI ≥ 35 with a serious comorbid condition, and past nonsurgical weight loss efforts have been unsuccessful. Long-term benefits of bariatric surgery include weight loss, long-term remission for type 2 diabetes, improved cardiovascular health, depression relief, treatment for obstructive sleep apnea, joint pain relief, improved fertility, and alleviation of other obesity-related medical conditions [10].

Candidates are often required by health insurance carriers to participate in a psychological evaluation prior to bariatric surgery. This can screen out those who have severe psychological issues but also can help identify those in need of pre-surgical treatment. Success of the surgery is highly dependent on subsequent maintenance of behavioral and lifestyle changes; psychological exams can help in identifying pre-surgery behavioral and eating related adaptations that may increase the likelihood of an individual's compliance following surgery [9].

Evaluating the reasons for success and failure among bariatric surgery patients has proved difficult [11]. A systematic review of preoperative predictors of weight loss following bariatric surgery found mandatory preoperative weight loss to be positively associated with weight loss post-surgery. Factors that were negatively associated with weight loss included preoperative BMI, super-obesity, and personality disorders [12]. Additionally, previous studies have shown a series of psychosocial factors to be important, including social support, socioeconomic status, conjugal satisfaction; cognitive functioning, self-esteem, and quality of life. On the other hand, a history of trauma or abuse, suicidal ideation, alcohol abuse, and drug abuse also are important [13-18].

The literature is not consistent on which dietary and psychological characteristics are most predictive of long-term surgery success. However, the majority of investigations have used post-operative weight loss as the primary dependent variable with predictor variables of depression, axis I and II disorders, history of psychiatric or Alcohol and Other Drug Abuse (AODA) treatment, and personality disorders [6,19-23].

Weight loss is only one measure of success, and it can be measured at different times in the post-operative period. This may provide an incomplete picture of what determines success for several reasons. Since

weight loss may be transitory, adherence to the post-operative guidelines is arguably a more predictive indicator of long-term success. Patients with pre-surgical histories of binge eating may be at greater risk for "grazing" post-operatively and therefore insufficient weight loss [24]. Those with weight loss may also be engaging in long-term behaviors that are not improving their quality of life. Several case studies report complications of eating disorders (e.g. anorexia nervosa, bulimia nervosa) following bariatric surgery [25].

Our study examines patient characteristics available from a preoperative psychological evaluation that may assist in identifying patients with the potential for adverse psychological and behavioral reactions following surgery that go beyond just weight loss. The ability to identify pre-surgical patients at risk for such post-operative difficulties would enhance a surgical program's capacity to prepare these patients, provide appropriate preoperative assistance and effective intervention, and identify patients who would likely require and benefit from post-operative psychological intervention.

Methods

Participants and setting

This is a case-control study that uses data that were collected between June 2004 and April 2006 from an academic hospital-based department of surgery, and was approved by the Medical College of Wisconsin Institutional Review Board. Participants were recruited by a nurse practitioner from the Department of Surgery during regularly scheduled post-gastric bypass surgery clinic follow-up visits between 12 and 18 months post-surgery. Inclusion criteria were based on the following: the patient had gastric bypass surgery for weight loss, was age 18 years or older, and met criteria for inclusion in one of the two groups-1) *Complicated response group:* including patients experiencing psychological adjustment problems, eating disorder, or compliance problem post-surgical, as defined below; 2) *Non-complicated response group:* including patients with no evidence of such problems. Both groups signed informed consent for participation in the study.

The study sample included the first 45 consecutive consented patients who met any of the criteria for complicated response and the first 45 who presented no evidence of the behavioral complications. The nurse practitioner enrolled the first 90 consecutive subjects who met inclusion criteria for each group-45 with complications, 45 without complications. During this process, the nurse practitioner was blind to the results of the psychological evaluations that had been conducted presurgically. Sample size estimation was based on a two-tailed hypothesis, *t*-test for comparison of independent means, alpha=.05, beta=.20 (80% power), and a medium effect size of .60, resulting in 44 subjects per group. Four patients in the complications group later withdrew consent and their data were not included in the analysis.

The complicated response group was identified based on their follow-up visits with evidence of any of the following

- Significant non-compliance with post-operative diet and nutrition instructions
- Inconsistent and inadequate compliance with required schedule of post-operative surgery clinic visits
- Development of unusual and potentially unhealthy post-operative diet and eating behaviors
- Anorexia, binge eating, or excessive sweet eating
- Significant dissatisfaction with post-operative weight loss
- Intense negative emotional reactions including anxiety, depression, or regret over having had surgery
- Significant deviation in either direction from the typical post-surgical weight loss rate of 10 to 15 pounds per month for the first 6 months, 5 to 7 pounds per month over post-surgical months 7 through 12, with the exception of deviations that occur secondary to an identified medical cause unrelated to eating behaviors, adjustment, or compliance. Significant deviation was determined by clinical judgment based on the surgical program experience with typical post-surgical weight loss, defined as less than 5 pounds or over 20 pounds per month during the first 6 months, and less than 2 pounds or over 15 pounds per month during the subsequent 7 to 12 months.

Data collection

Participation in the study required permission to use specific information from patients during their pre-surgical psychological evaluation, as well as their post-surgical follow-up clinic visits. Pre-surgical information included data available from the psychological evaluation involving structured clinical interviews and completion of self-report inventories. Examples of relevant patient information during the structured clinical interviews included weight history, age of onset of obesity, weight loss history (number and type of weight loss efforts), psychiatric history (past and current psychiatric diagnoses), history of binge eating, stress and emotional eating (or other eating disorders), history of snack and sweet eating, social/family support for surgery, understanding of the surgery and implications for post-surgical diet and eating habits, social history, and any concerns or recommendations raised at the time of psychological screening. Self-report inventories completed by surgical candidates as part of the psychological screening, and of interest for the purpose of the present study, include the Symptom Checklist 90-Revised (SCL 90-R) [26], Weight Locus of Control Scale (WLOC) [27], measures of weight loss self-efficacy, including assertiveness and social pressure, from the Weight Efficacy Life Style Questionnaire (WELSQ) [28], attitudes about obesity [29], Emotional Eating Scale (EES) [30], the Body Image Avoidance Questionnaire (BIAQ) [31], the Multidimensional Body-Self Relations Questionnaire (MBSRQ) [32], and social desirability [33,34].

Relevant information from the surgery clinic file included pre-surgical weight, current weight, medical/surgical complications, and specific problems noted during follow-up that resulted in the patient's designation as having a difficult post-surgical adjustment. Table 1 reports the means of variables in our data divided by whether the respondent belonged in the group with complications or the group without. Note that several of these scales, including the BIAQ, the General Severity Index of the SCL90-R, WELSQ, the EES, the WLOC and the social desirability scale are each summary measures of subscales. We do not report the individual scales in Table 1, except for those that ultimately prove predictive of post-operative complications. These are specifically the WELSQ social pressure subscale and the EES-Depressive mode subscale.

Variable selection

We employed a number of techniques to identify which variables were likely to indicate complications. Given our large set of potential covariates, it was not tractable to include a large set in our final model. So, we first engaged in a series of selection mechanisms to include the best covariates. The first was to consider every factor individually as simple predictors of complications through logistic regression. We then identified those factors that showed some differences across the groups as a base set of potential regressors (Figure 1). Those that showed a p-value ≤ 0.10 difference were included in the potential set of predictors for the subsequent data analysis. All tests are conducted as two-tailed tests.

We then engaged in two stepwise regression procedures to identify additional potential predictors for complications that might have been missed by the simple comparisons. The first was a forward selection procedure that begins with no covariates and adds those that improve

the model's fit (as measured by F-statistics) until the model cannot be improved upon. The second is backward elimination, which starts with all covariates and deletes those that improve the model's fit. Stepwise regression is a common ad hoc technique routinely employed in statistical investigations. However, stepwise regression does not necessarily find the best set of predictors [35].

Finally, we supplemented the above classical variable selection procedures with Bayesian variable selection *via* Bayesian Additive Regression Tree (BART) models as proposed by Chipman et al. [36]. This method, based on classification trees, is a natural choice for variable selection. Table 2 summarizes the variables that were added to the model based on each of these selection models. We employed a variety of methods that would quantify the relative importance of each of these variables and ensure the robustness of our findings.

Estimation models

We noted first that the respondents across groups were highly comparable on demographics and baseline physical characteristics, including age, gender, weight gain in the past five years, and family obesity prevalence and support, as well as their exercise history. This similarity is visible in both groups (Table 1), but also illustrated through a variable selection model. Thus, the main differences across groups and the items identified in our variable selection procedures were part of the variables that came from the psychological screening.

Our first model included those factors identified in table 2 in a logistic regression that were identified as primary potential determinants of complications, both using the SE total scale in one model and the two subscales in another. We use logistic regression following the assumption that our outcome variables follow a Bernoulli distribution. We then added the secondary determinant from table 2 and eliminated the insignificant variables from the first model.

Our second approach took the most informative of the models from the basic approach and ensures validity. First, we accounted for potential non-comparability along non-psychosocial lines of the group that showed complications *vs* the group that showed no complications. Although we believe table 1 suggests this comparability exists, we weighted the observations in the non-complication group based on their comparability to the complication group. We weighted observations specifically based on age, gender, weight gain in past five years, age at surgery, approximate age of obesity onset, and whether there was a prevalence of obesity in the family. This weighting of non-experimental data follows procedures outlined in Linden (2014) [37] and Hong (2012) [38]. We also tested for robustness of eliminating the few respondents that exhibited a poor understanding of the surgery.

	Showed complications	Did not show complications
Age at surgery	40(9)	41(11)
Approximate age of obesity onset	11.1(6.5)	11.7(7.7)
Female	0.85	0.89
Weight gain 5 years before surgery	57(41)	61(43)
Understand surgical procedure and diet afterwards	0.95	0.78
Family prevalence of obesity	0.83	0.78
Family supportive of surgery	0.78	0.76
Hours sedentary	9(4)	10(4)
Blocks walked	12(11)	13(12)
Miles wiled	5 (4)	5(4)
Exercise	0.32	0.27
Evidence of psych history*	0.66	0.44
Currently on medication	0.39	0.29
Emotional problems	0.34	0.33
BIAQ	45.41(13.08)	41.36(12.25)
General Severity Index (SCL90-R)	58.76(11)	58.38(8.78)
Stress eating	0.73	0.62
Binge eating	0.22	0.18
Abuse history	0.32	0.49
Trauma history	0.34	0.36
WELSQ	125.20(34.74)	120.84(24.19)
Social Pressure	25.95(8.76)	24.40(7.00)
(EES)	33.29(21.25)	27.80(16.45)
Depressive Mood	9.44(4.62)	7.44(4.39)
Weight Locus of Control Scale (WLOC)	9(3.01)	8.31(2.87)
Social Desirability Scale	12.46(4.01)	13.31(3.48)
Multidimensional Body-Self Relations Questionnaire-Appearance Orientation (MBRSQ-AO)	3.37(.64)	3.60(.72)
Multidimensional Body-Self Relations Questionnaire-Appearance Evaluation (MBRSQ-AE)	1.95(.68)	2.11(.74)
Sample size	41	45

Table 1: Patient characteristics for the group who showed complications and the group that did not show complications
Note: Reported are means and standard deviations from the experimental groups. Subscales are not reported but are part of the remaining analyses.

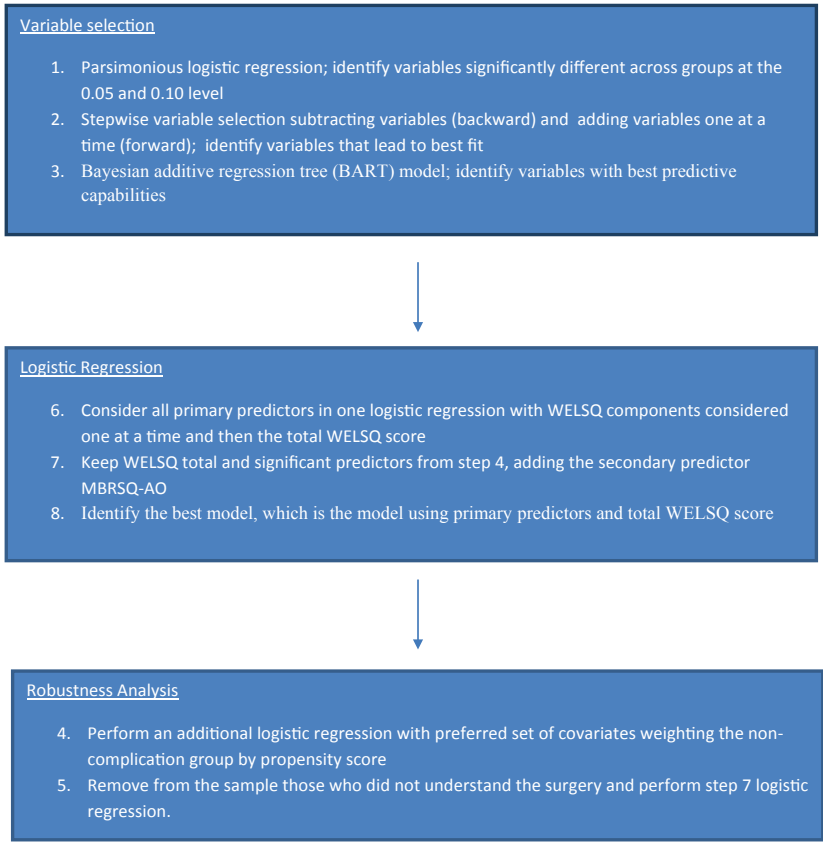

Figure 1: Steps in the Analysis

Variable selection procedure	Variables that were selected by the procedure
Mean comparison table and parsimonious logistic regression	Primary (significant at the .05 level): EES depressive subscale (+) Psychological history (+) Secondary (significant at .10 level): MBRSQ-AO (-)
Backward and forward elimination	Psychological history Abuse history
Bayesian Additive Regression Trees	EES depressive subscale WELSQassertiveness WELSQ social pressure subscale

Table 2: Selection of variables that are potentially predictive of complications
Note: These rows list the variables that were deemed important from various variable selection procedures. The first row reports those variables that were significant (p-values equal to .05 or .10 in a series of simple logistic regressions where the outcome variable is complications and the explanatory variable is each variable in our database included one at a time. These three variables were the only ones that were significant. The second row includes the results of a stepwise variable selection procedure that adds variables one at a time (forward) or subtracts variables one at a time (backward) to a regression with complications as the outcome variable until the model of best fit is achieved. The models suggest the two variables represent the best fit. In the final row, a Bayesian additive regression tree (BART) model as outlined by Chipman et al. [36]. This results in three additional variables that are potentially predictors of complications.

Results

Basic estimations

Table 3 summarizes the results for logistic regressions for determining complications. Each column is a separate logistic regression. Columns (1) and (2) include the primary determinants from table 2. Odds ratios are reported with p-values in parentheses. Given that neither the WELSQ assertiveness nor social pressure subscales proved significant separately, we use the total SE scale in column (3), which evolves as our most informative model. These estimates reveal that a higher score on the eating when in a depressive mood subscale to the EES assessed prior to surgery has significant and positive effects on the likelihood of complications. Specifically, moving up 1 point on the 20-point scale increases the likelihood of complications by about 16%. A psychiatric diagnosis has an effect that is only marginally significant (p=0.091). Interestingly, a history of abuse significantly lowers the likelihood of complications.

The non-significant WELSQ measures and marginally significant psychological history measures are dropped in column (4) and the secondary factor from table 2 (MBRSQ appearance orientation subscale) is added. The latter shows a marginally significant reduction in complications (p=0.091). The other factors (EES depressive and abuse history) show about the same effects as in the first two columns. Given the model fit was best in third column, this is our preferred model and the one we carry forward to the next section.

Adjusted estimations

One potential limitation is that we assume that the groups with complications and without are similar except for the variables included in the logistic regressions. Table 1 supports this assumption. We do adjust our estimates in several ways to ensure that there are no important differences that might affect the results. We first utilize a weighting mechanism that attempts to more closely match respondents in the complications to those in the non-complications group on a number of characteristics. These results are presented in the first column in table 4 and continue to suggest the strongest influence on complications being those who emotionally eat when depressed. The history of abuse also continues to be significant, as do the self-efficacy measures and psychological history.

As a final test, we remove those respondents who did not display a good understanding of the post-surgery diet and adjustment regimen. There were 12 such people in our data. Oddly, most were in the group that did not show complications. Regardless, among those with a demonstrated understanding, the results still strongly suggest it is emotional eating while depressed that has the strongest and most significant negative impact.

Discussion

The aim of this study was to use retrospective data that linked observed problematic behaviors of patients in follow-up visits following bariatric surgery to a rich set of characteristics of those individuals before surgery. Of most interest to us were the measures taken from a psychiatric exam administered to these patients. Previous studies have focused on weight loss as the primary measure of surgery success [6, 19-23]. Although weight loss and failure to adapt to a healthy stable life after surgery are inversely related, insufficient weight loss is not the only casualty of poor adaptation to surgery. We used a broader set of observed behaviors that suggested complications from surgery.

Our study also moved beyond using merely the presence of psychiatric disorders to predict surgery success. Depression, axis I and II disorders, a history of psychiatric or AODA treatment, and personality disorders have been linked to decreased surgery success [6,19-23]. We expand on these measures by using information from the preoperative psychiatric evaluations. Finally, our study is unique in utilizing statistical techniques to identify the variables that most likely are predictive of bariatric surgery success from a large set of variables. Because our study has a limited number of observations and many possible predictors, these techniques allowed us to identify a small number of potential predictors that we could then subject to a number of logistic regression.

	Model with "primary predictors" from table 2, including WELSQ assertiveness (1)	Model with "primary predictors" from table 2, including WELSQ social pressure (2)	Model with "primary predictors" from table 2, including WELSQ composite measure (3)	Model removing SE scale variables and adding MBRSQ-AQ (4)
EES depressive	1.117 [1.00,1.24] (0.042)	1.136 [1.02,1.27] (0.027)	1.160 [1.03,1.31] (0.017)	1.177 [1.04,1.33] (0.008)
Psychological history	2.235 [0.87,5.72] (0.093)	2.233 [0.86,5.76] (0.096)	2.274 [0.87,5.89] (0.092)	
Abuse	0.361 [0.14,0.95] (0.040)	0.361 [0.14,0.96] (0.042)	0.361 [0.13,0.97] (0.042)	0.403 [0.15,1.06] 1.058615 (0.065)
MBRSQ-AO				0.513 [0.23,1.14] (0.101)
WELSQ assertiveness	1.023 [0.96,1.09] (0.482)			
WELSQ social pressure		1.045 [0.098,1.11] (0.173)		
WELSQ Total			1.015 [1.00,1.03] (0.109)	1.015 [0.99,1.03] (0.112)
Outcomes correctly Classified	63.9%	67.4%	67.4%	68.6%
Prob > chi2	0.0185	0.0100	0.0072	0.0075
Pseudo R-squared	0.0995	0.1115	0.1178	0.1171

Table 3: Determinants of unhealthy behaviors using logistic regression (Dependent variable: Complications)
Note: Each column are results from a separate logistic regression model of complications regressed on the variables in the leftmost column. Odds ratios are reported, with 95% confidence intervals in brackets and p-values in parentheses. The first three columns use the primary predictors from table 2 with the WELSQ assertiveness subscale (column 1), the WELSQ social pressure subscale, and the WELSQ total scale (column 3), each entered one at a time. The fourth column uses the MBRSQ-AO scale instead of the WELSQSE variables. Column (3) is the preferred specification, having both the highest pseudo R-squared and lowest prob>chi^2.

	Propensity score weighted estimation (1)	Propensity score weighted estimation removing those who did not understand surgery (2)
EES depressive	1.168 [1.04,1.32] (0.011)	1.139 [1.00, 1.30] (0.045)
Psychological history	2.705 [1.03,7.09] (0.043)	2.734 [0.98,7.67] (0.056)
Abuse	0.315 [0.11,0.88] (0.027)	0.315 [0.11,0.93] (0.037)
WELSQ total	1.0168 [1.00,1.03] (0.047)	1.016 [0.99,1.03] (0.096)

Table 4: Determinants of unhealthy behaviors using propensity score matching (Dependent variable: Complications after surgery)

Note: Each column are results from a separate logistic model of complications regressed on the variables in the leftmost column. Odds ratios are reported, with 95% percent confidence intervals in brackets and p-values in parentheses. The preferred model (column 3) from table 3 is used, with two adjustments. The first column weights each observation in the non-complication control group relative to how closely the patient matches patients in the complication group based on age, gender, weight gain in past five years, age at surgery, approximate age of obesity onset, and whether there was a prevalence of obesity in the family. The Prob>chi^2 for this model is 0.0045 and Pseudo R-squared is 0.134. The second column removes those people who showed a poor understanding of the surgery and recovery prior to the procedure. The Prob>chi^2 for this model is 0.0261 and Pseudo R-squared is 0.114.

One variable emerged as a consistent predictor among the many factors included in our data set. The Emotional Eating Scale (EES) measures one's eating in a variety of mood states. Although other studies have looked at depression, we specifically identify eating while depressed as a major predictor of poor adherence to a stable post-surgery diet and lifestyle. Wedin et al. [39] found that a self-reported history of emotional eating was associated with weight loss after bariatric surgery, at least in the short-term, and conclude that emotional eating should not necessarily be a contraindication for surgery. Our results brings into question this conclusion by showing that depressive eating is correlated with problematic behaviors post-surgery that are inconsistent with long-term success. We do so using a more psychometrically sophisticated metric of emotional eating on a 20-point scale and a deeper measure of problematic behavior following surgery.

One implication of this finding is that screening for emotional eating while depressed could be used in a clinical setting to better identify patients that might struggle post-surgery. Interventions could be designed and tested to help improve outcomes given this information.

Another variable that proved significant throughout our analysis was a reported history of abuse. This had the counter-intuitive effect of reducing the likelihood of experiencing complications after surgery. The major issue with this variable might be that abuse is self-reported. Those who report abuse may have received treatment and are better able to cope with matters post-surgery. That would assume that actual abuse is more prevalent than reported in our data.

Limitations

The study data are retrospective in nature. No specific attempt was made to recruit similar subjects randomly from the group with complications and the group without complications. Assessment of complications occurred between 12 and 18 months after surgery. There may have been complications that emerged after this period in the group with no complications. Also, only individuals who had post-surgery appointments were observed. Since clinical observation were used and recorded, there might be bias resulting from the differences in the calculation and registration of the data. Many variables, including family support and a history of abuse, were self-reported. The psychological evaluation involved structured clinical interviews and completion of self-report inventories, which may introduce some bias, although it is likely limited. Also, several potential predictors, specifically being preoccupied with outward appearance, having psychological treatment history, and self-efficacy, were marginally significant in some tests but not robust. We do not have information on past surgeries, which is a negative determinant of surgery success [40]. This suggests that larger sample sizes might show these to be important factors as well.

Conclusions

We assessed the influence of a myriad of factors measured pre-surgery on the likelihood that bariatric surgery patients were observed to have complications adjusting to healthy diet and weigh loss guidelines following bariatric surgery. We found one factor from the psychological screening that proved to be important in all of our tests. Specifically, whether one scored highly on the emotional eating scale while depressed increased the chance of complications.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. We received IRB approval from the Medical College of Wisconsin.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

Conflict of Interest

The authors declare that they have no conflict of interest to report.

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