HHS Public Access
Author manuscript
Int J Eat Disord. Author manuscript; available in PMC 2017 December 01.

Published in final edited form as:
Int J Eat Disord. 2016 December ; 49(12): 1058–1067. doi:10.1002/eat.22578.

Eating Pathology and Experience and Weight Loss in a Prospective Study of Bariatric Surgery Patients: 3-year Follow-up

Michael J. Devlin, MD[1], **Wendy C. King, PhD**[2], **Melissa A. Kalarchian, PhD**[3], **Gretchen E. White, MPH**[2], **Marsha D. Marcus, PhD**[4], **Luis Garcia, MD**[5], **Susan Z. Yanovski, MD**[6], and **James E. Mitchell, MD**[7]

[1]Columbia University College of Physicians and Surgeons / New York State Psychiatric Institute, New York, NY, United States

[2]Epidemiology, University of Pittsburgh Graduate School of Public Health, Pittsburgh, PA, United States

[3]School of Nursing, Duquesne University, Pittsburgh, PA, United States

[4]Department of Psychiatry, University of Pittsburgh School of Medicine, Pittsburgh, PA, United States

[5]Sanford Health System, Fargo, ND, United States

[6]Division of Digestive Diseases and Nutrition, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, United States

[7]Neuropsychiatric Research Institute, Fargo, ND, United States

Abstract

Objective—Bariatric surgery results in significant long-term weight loss, albeit with considerable variability. This study examines the prognostic significance of eating pathology as determined by a structured interview, the Eating Disorder Examination-Bariatric Surgery Version (EDE-BSV).

Method—Participants (N=183) in this sub-study of the Longitudinal Assessment of Bariatric Surgery (LABS) Research Consortium were assessed using the EDE-BSV, independent of clinical care, pre-surgery and annually post-surgery. We examined eating pathology and experiences at several frequency thresholds (present, ≥ monthly, ≥ weekly) over 3 years, and utilized mixed models to test their associations with percentage weight loss from baseline at years 1, 2 and 3.

Results—The prevalence of several forms of eating pathology declined pre- to 1-year post-surgery, including ≥ weekly objective bulimic episodes (11.6% to 1.3%), loss of control (LOC) eating (18.3% to 6.2%) and picking/nibbling (36.0% to 20.2%) (p for all<.01), and regular evening hyperphagia (16.5% to 5.0%, p=.01), but not cravings (p=.93). Mean EDE global score, and hunger and enjoyment scores, also declined (p for all<.01). These metrics remained lower than baseline through year-3 (p for all<.01). Pre-surgery eating variables were not related to weight loss (p for all≥.05). However, post-surgery higher EDE global score and greater hunger were

Conflicts of Interest: Drs. King, Garcia, White, and Yanovski report no conflicts of interest.

independently associated with less weight loss post-surgery (p for both≤.01), while cravings were associated with greater weight loss (p=.03).

Conclusion—Pathological eating behaviors and experiences are common pre-surgery and improve markedly following surgery. Post-surgery pathological eating-related experiences and attitudes and hunger may contribute to suboptimal weight loss.

INTRODUCTION

Obesity has reached epidemic proportions in the United States.[1] Unfortunately, most nonsurgical therapies, including pharmacotherapy and lifestyle interventions, yield benefits that are usually modest and short-lived.[2] Bariatric surgery procedures, in contrast, result in significant long-term weight loss among individuals with severe obesity,[3,4] albeit with considerable variability. The association of eating-related pathology, other than binge eating (BE) or binge eating disorder (BED), with bariatric surgical outcome, has received relatively little attention. In particular, the significance of sub-syndromal eating pathology and experience, apart from loss of control (LOC) eating, is poorly understood.

Among adults with severe obesity seeking bariatric surgery, rates of psychopathology, including eating pathology, have been found to be high in studies employing structured interviews,[5] generally considered the assessment gold standard.[6] In four studies that conducted interviews separately from clinical care, lifetime and current prevalence of any eating disorder ranged from 15.2–50.0% and 13.2–37.7%, respectively, and corresponding lifetime and current prevalence of BED ranged from 13.1–50.0% and 10.1–23.3%, respectively.[5,7–9] Despite considerable variability across studies, it is clear that eating disorders occur at a higher frequency among surgical candidates than in the general population. For example, the lifetime prevalence of any disorder of BE, including subthreshold BED, in the general population is 4.5%.[10]

Several studies have examined the association of BE or BED pre-surgery with weight loss following surgery. As recently reviewed by Meany et al.,[11] only a minority of the studies found that pre-surgery BE or BED predicted less weight loss or more weight regain. Studies examining post-surgery BE have generally focused on LOC eating, i.e., a sense of loss of control without the requirement for an objectively large amount of food consumption, which may not be possible following bariatric surgery. Of the 15 studies that examined post-surgery BE, BED or LOC eating, 14 found that these behaviors were associated with less weight loss and/or more weight regain, and that the patients who had BE or BED post-surgery were almost exclusively those who had problems with BE prior to surgery. [11] Thus, the persistence of uncontrolled eating has emerged as an important potential negative predictor of surgical weight loss and weight loss maintenance.

Another problematic eating behavior that might influence post-surgery weight loss is night eating syndrome .[12] Although the criteria for night eating syndrome (NES) have varied across studies, most criteria sets include the regular occurrence of evening hyperphagia (i.e., consumption of 25% or more of daily food intake after the evening meal) and/or nocturnal eating. NES is associated with psychopathology and has some overlap with BED, as well as with nocturnal sleep-related eating disorder (NSRED),[13] a parasomnia characterized by partial arousal from sleep associated with eating. As with BED, widely divergent rates of NES have been found in bariatric surgery candidates.[14,15] The literature on post-surgical night eating and its long-term impact on weight permits no firm conclusions at this time.

Other eating abnormalities that have been studied in bariatric surgery samples include "picking and nibbling" or "grazing," i.e., the consumption of small amounts of food at frequent intervals,[16,17] as well as traditional eating disorders, such as anorexia nervosa or bulimia nervosa, which may involve the use of compensatory methods to prevent or limit weight gain. Although anecdotal reports suggest that features of eating disorders such as unhealthy dietary restriction, heightened concern with body shape or weight, and the use of compensatory methods may occur following surgery, prevalence data are not yet available.[18–20]

Finally, differential weight loss between bariatric surgical procedures is thought to be partially explained by differences in how food is experienced post-surgery, e.g., hunger, cravings and enjoyment.[21] For example, some individuals may develop an aversion to sweets following Roux-en-Y gastric bypass (RYGB), due to dumping. However, few studies have investigated how eating-related experiences relate to post-surgery weight loss.

The current study was designed to examine eating pathology and experiences and their associations with pre- to post-surgery weight loss in a cohort evaluated prior to undergoing bariatric surgery and followed prospectively for 3 years. A previous study conducted in this sample reported that having a post-surgery eating disorder, principally BED, as determined by the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria, was associated with less weight loss two or three years following bariatric surgery.[22] This report builds on that finding by focusing on specific behaviors (e.g., LOC eating, objective overeating and compensatory methods) and eating-related experiences (e.g., hunger, cravings and enjoyment), rather than full syndrome disorders.

METHOD

Design, setting and participants

The current study is part of the LABS Consortium, a multisite observational cohort study of participants undergoing bariatric surgery, which has been described in detail.[4,23–25] The LABS-3 Psychosocial Study included 202 patients at three of the six LABS-2 clinical centers: The Neuropsychiatric Research Institute, Fargo, ND; Columbia-Weill Cornell Medical Centers in New York, NY; and the University of Pittsburgh in PA. The Institutional Review Boards at each center approved the protocol and consent forms. The 197 LABS-3 participants who underwent RYGB or laparoscopic adjustable gastric band (LAGB) and were not known to be pregnant or within 6 months post-partum at follow-up were considered for the current analysis. Of those, 183 had pre-surgery data and at least one annual follow-up assessment in years 1–3. Of the 14 participants who provided no follow-up data, 12 refused participation, 2 died during follow-up, and 2 could not be reached.

Measures

We obtained information on eating pathology and experiences using the Eating Disorder Examination-Bariatric Surgery Version (EDE-BSV), a modified version of the Eating Disorder Examination (EDE),[26,27] a semi-structured interview designed to assess eating disorder psychopathology. The modifications include additional questions that assess eating related experiences and problems specific to bariatric surgery.[28] To minimize the possibility that participants' responses would be influenced by concerns about their impact on eligibility for surgery and clinical care, initial interviews were conducted independently of the routine pre-surgery screening process, and patients were told that the data would not be shared with the bariatric surgical team unless a participant's safety was at stake (e.g., suicidal thoughts). All raters were carefully trained in the use of the EDE-BSV, completed audiotape-monitored practice sessions, and participated in monthly supervision conference calls.

The EDE-BSV assessed objective bulimic episodes (OBE), subjective bulimic episodes (SBE), LOC eating, and objective overeating episodes (OOE). In this classification, "objective" denotes an unusually large amount of intake as rated by the interviewer, "subjective" denotes an amount deemed unusually large by the respondent but not the interviewer, "bulimic" denotes the experience of loss of control, and "overeating" denotes the absence of loss of control in episode that the respondent considered unusually large. LOC eating is reported separately from OBE and SBE and denotes any overeating episode in which the respondent felt a loss of control, regardless of amount of intake. Because the frequency threshold for clinical relevance in this context is unknown, participants were classified by whether they did or did not report each behavior at least once (i.e., present), at least once per 28 days (i.e., ≥ monthly), and at least four times per 28 days (i.e., ≥ weekly), on average over the past 6 months. Participants were also classified by whether they did or did not report compensatory methods (self-induced vomiting, chewing and spitting food, laxative misuse, diuretic misuse, or driven exercise) at least once (i.e., present) in the past 6 months. The remaining variables were assessed in reference to the past 28 days. Responses from the Night Eating Questionnaire (NEQ), included within the EDE-BSV, were used to calculate a NES score (range: 1–52) and a cut point of ≥30 was used to categorize participants as reporting a strong indication of NES.[29] In addition, responses to an individual item from the NEQ were collapsed to report the prevalence of evening hyperphagia, defined as regular consumption of >25% of daily intake after supper, i.e. the evening meal. "Picking and nibbling" was assessed with the question, "have you picked at or nibbled, or grazed food between meals and snacks. By 'picking' I mean eating in an unplanned and repetitious way (excluding loss of control)." Participants were classified by whether they experienced picking/nibbling on at least one day in the past 28 days (i.e. present) and on at least 4 days (i.e. ≥ weekly). Cravings were assessed with the questions, "do you experience cravings for food?" and, "how would you rate the strength of your cravings?" Participants were classified as having experienced cravings if they rated their cravings strength as 4 or 5 on a 0 [none]-5 [extreme] scale. Level of hunger and enjoyment of eating were also rated on a scale of 0 [none]-5 [extreme/constant]. EDE subscale scores, including restraint, eating concerns, shape concerns, weight concerns, and the EDE global score were calculated according to standard procedures (range = 0–6), with higher scores indicating more frequency or severity of pathological eating behaviors and associated psychopathology.[26]

Anthropometric measurements were made by trained personnel. Height was measured to the nearest inch using a wall-mounted stadiometer at the pre-surgery assessment. Participants' weights were measured to the nearest pound at pre-surgery and annual assessments with bare feet and in light-weight clothing, using a study-purchased standard scale (Tanita Body Composition Analyzer, model TBF-310, [Tanita Corporation of America, Inc., Arlington Heights, IL]). Self-reported weight, which has been validated in this population,[30] was utilized when in-person follow-up assessment was not possible. Including pre-surgery and all follow-up assessments, 8.1% (51/631) of weights were self-reported. Percent weight loss was calculated as pre-surgery weight minus follow-up weight, divided by pre-surgery weight. Other demographic data were self-reported.

Data Analysis

Analyses were conducted using SAS version 9.3® (SAS Institute, Cary, NC, USA). Statistical significance was set at $p<.05$; tests were two-sided. Descriptive statistics (frequencies and percentages for categorical variables; medians and 25th–75th percentiles for continuous variables) were used to summarize pre-surgery characteristics and observed data by time point.

Longitudinal analyses were performed with mixed models, which allow for missing data and can simultaneously model the relationship between longitudinal outcomes (i.e., observed at years 1, 2 and 3) and baseline or longitudinal covariates[31]. Models used all available data, and controlled for baseline characteristics related to missing follow-up data (i.e., age, race [white vs. non-white], and rates of diabetes, hypertension, and ischemic heart disease).[32]

Poisson mixed models with robust error variance were used to compare prevalence, and linear mixed models were used to compare mean values of eating pathology and experience over time. When there was a significant difference by time point, pairwise comparisons were made between pre-surgery versus year 1 (short-term pre- to post-surgery change), pre-surgery versus year 3 (longer-term pre- to post-surgery change), and year 3 versus year 1 (post-surgery change). Simulation was used to adjust for multiple comparisons.[32,33] With a sample size of 183, there was 80% power to detect a difference of: 1) 5% between prevalence rates for uncommon eating behaviors (e.g. 6% baseline prevalence) and 14% for common eating behaviors (e.g. 50% baseline prevalence), or 2) 0.3 between mean scores, with standard deviations of 1.0. Only observed data are presented for eating pathology with baseline prevalence <6%. Descriptive statistics were used to report the proportion of patients with post-surgery onset (vs. continued) eating pathology.

A series of linear mixed models were used to test and estimate associations between pre-surgery eating pathology and experience (bulimia/overeating episode variables: OBE, SBE, LOC and OOE; NES variables: evening hyperphagia and NES score; picking/nibbling, cravings, level of hunger, level of enjoyment of eating, and EDE global score) and pre- to post-surgery % weight loss at years 1, 2 and 3. Bulimia/overeating episode variables and picking/nibbling were considered at the ≥ weekly and ≥ monthly thresholds. In addition to time, all models adjusted for sex, BMI and surgical procedure,[4,34,35] as well as site to adjust for correlations among patients from the same site. Based on these results, the bulimia/overeating episode variable and the NES variable most strongly associated with weight loss, along with the remaining eating pathology and experience variables were entered into a single model, with the same control variables. With a sample size of 183, there was 80% power to detect an association with independent variables that accounted for at least 2% of the variance in weight loss, controlling for covariates with an R^2 of 0.40. Non-significant eating pathology and experience variables were eliminated via backwards elimination. Finally, the analysis was repeated with post-surgery eating pathology and experience, controlling for the pre-surgery values of the respective post-surgery variables. Due to low prevalence and frequency of bulimia and overeating episode variables post-surgery, only SBE and LOC at the ≥ monthly threshold were considered.

Associations between surgical procedure (RYGB, LAGB standard band [0–10 cc fill volume] and LAGB large band [0–14 cc fill volume]) and select post-surgery eating pathology and experience variables related to weight loss (i.e., LOC ≥ monthly, cravings, EDE level of hunger score and EDE global score) were evaluated with mixed models, controlling for site, the baseline value of each outcome, and baseline factors that differed by surgical procedure (i.e., sex and BMI). When differences were not detected with differentiation of standard and large banded LAGB, procedure categories were collapsed to compare RYGB to LAGB.

RESULTS

Among those with baseline data who were alive at follow-up, the EDE-BSV was completed by 85% of surviving participants (N=168/197), 78% (N=152/196), and 67% (N=131/195), at years 1, 2 and 3, respectively.

Participant Characteristics

Baseline characteristics of the analysis sample (N=183) are shown in Table 1. Approximately one sixth of the sample was male (16.9%, n=31). Most were white (92.9%, n=169), educated beyond high school (82.6%, n=142), and underwent RYGB (60.7%, n=111). The sex distribution (p=0.002) and BMI (p=0.0001) significantly differed by surgical procedure. Median (25th, 75th percentiles) percent weight loss was 36.1% (29.8, 39.6) at 1 year, 36.3% (29.3, 41.4) at 2 years and 33.0% (24.9, 38.2) at 3 years for RYGB; 13.8% (9.4, 20.2) at 1 year, 14.4% (9.0, 19.0) at 2 years and 15.2% (8.0, 20.7) at 3 years for LAGB standard band; and 11.2% (5.5, 17.2) at 1 year, 11.7% (4.5, 17.0) at 2 years and 11.0% (2.2, 18.1) at 3 years for LAGB large band.

Eating Pathology and Experience Prior to and Following Surgery

Modeled prevalence rates and mean scores for eating pathology and experience at baseline and at years 1–3 following surgery are shown in Table 2. Regardless of frequency threshold, the prevalence of OBE, LOC eating and OOE decreased following surgery. There was no change in prevalence of OBE or OOE from 1 to 3 years post-surgery. The prevalence of any LOC eating was lower at year 3 vs. 1, but prevalence of monthly or weekly LOC eating was not significantly different during this period. The prevalence of SBE was not significantly different from baseline at year 1, but by year 3, any SBE and monthly SBE were significantly lower than baseline, while the prevalence of weekly SBE was not significantly different from baseline.

Only 6.4% of participants endorsed engaging in a compensatory method prior to surgery (Table 2). There was not a significant pre- to post-surgery difference in the prevalence of engaging in at least one compensatory method, although we were only powered to detect a large effect size. Specific compensatory methods were too rare to model (see Supplemental Table 1 for observed compensatory method prevalence by time point). A NES score ≥ 30 (i.e., strong indication of NES) had less than a 2% prevalence at all time points. However, following surgery there was a significant reduction in the prevalence of evening hyperphagia, and mean NES score decreased. Likewise, there were reductions in the prevalence of picking or nibbling and cravings, although prevalence of cravings was only significantly lower in year 3 (vs. baseline or year 1). The EDE global score, as well as most components (i.e., eating concerns, shape concerns, weight concerns) were significantly lower in years 1 and 3 versus pre-surgery. In contrast, compared to pre-surgery, the mean restraint score was significantly lower in year 3 but not year 1. The mean levels of enjoyment and hunger were also significantly lower in years 1 and 3 versus pre-surgery, despite a significant increase in hunger from 1 to 3 years. Observed frequencies and mean scores for eating pathology and experience, by time point, are presented in Supplemental Table 1. This table also indicates post-surgery onset vs. pre- and post-surgery occurrence of pathological eating behaviors or experiences. Post-surgery onset of picking and nibbling, and for cravings were particularly common.

Association of Eating Pathology and Experience with Weight Loss

Controlling for site, sex, baseline BMI, surgical procedure, and factors related to missing follow-up data, there were no statistically significant associations between pre-surgery eating pathology or experiences and pre- to post-surgery % weight loss at years 1, 2 and 3 (Table 3). Associations between each post-surgery eating pathology or experience and pre- to post-surgery % weight loss at years 1, 2 and 3, with control for potential confounders, are shown in Table 4. LOC eating ≥ monthly (p=0.04), higher EDE global score (p<0.0001) and higher hunger rating (p=0.002) were each associated with less % weight loss. However, in the model considering multiple post-surgery eating-related variables, lower EDE global score [β=−2.5 (95% CI: −3.6–−1.3) per 1 point higher; p<0.0001], less hunger [β= −1.0 (95% CI: −1.7–−0.3) per 1 point higher; p=0.003], and cravings [β=1.5 (95% CI: 0.1–2.9); p=0.03], but not LOC eating ≥ monthly, were associated with greater % weight loss, indicating more pathological eating-related experiences and attitudes and greater hunger post-surgery were independently associated with less % weight loss, while cravings were associated with greater % weight loss.

Associations Between Surgical Procedure and Select Measures of Eating Pathology and Experience

Controlling for potential confounders, surgical procedure was not independently related to post-surgery ≥ monthly LOC eating (p=0.11), hunger score (p=0.89), or cravings (p=0.37).

This was also true when RYGB was compared to LAGB (standard and large bands combined) (p for all ≥0.05). However, compared to RYGB, LAGB large band and LAGB standard band were related to a higher eating pathology global score post-surgery (β=0.5 (95%CI: 0.2–0.8), and β=0.4 (95%CI: 0.1–0.6), respectively).

DISCUSSION

The present study suggests that pathological eating behaviors and eating-related experiences are common prior to bariatric surgery and improve dramatically following surgery. Our study extends prior work by showing maintenance of improvements over a 3-year follow-up period. All measures of bulimia and overeating were endorsed by one-fourth to less than one-half of pre-surgical patients. By year 1 post-surgery, the occurrence of OOE nearly disappeared, perhaps unsurprisingly in view of the mechanical constraints imposed by surgery. OBE prevalence was also drastically reduced by year-1 post-surgery. LOC, although very much reduced from its pre-surgery prevalence, remained a problem for a minority (e.g., 12% present, 7% ≥ weekly at year 3). Finally, SBE prevalence remained unchanged following surgery. Evening hyperphagia was reduced by approximately two-thirds following surgery, but persisted in a minority (5–6% in years 1–3). Picking and nibbling was endorsed by half of patients prior to surgery and, while significantly reduced, was reported by about one-third of patients following surgery. Hunger and enjoyment also consistently decreased from pre- to post-surgery assessments. Global EDE score and its component factors, with the exception of restraint, decreased dramatically as well. Notably despite overall decreases in prevalence, we observed some instances of post-surgery onset of pathological eating behaviors or experiences, particularly for picking and nibbling, and for craving.

In addition to pre- vs. post-surgery comparisons, the 3-year follow up period permitted an examination of changes during the post-surgery follow-up in which the majority of patients transition from weight loss to weight maintenance.[4] There was relatively little change in eating-related behaviors or experiences over this 3 year period. The presence of any SBE, any LOC eating and cravings continued to decrease during this timeframe. In contrast hunger increased from 1- to 3-year follow-up, unrelated to surgical procedure, although not to pre-surgery levels.

None of the pre-surgery eating-related variables assessed in this study, which ranged in prevalence from 6–50% were significantly related to weight loss, which indicates that none of these variables independently contributed to at least 2% of the variance in weight loss. This finding is in line with prior studies, which typically have not detected associations between pre-surgery binge or LOC eating and weight loss.[11,22] Recently, however, Morseth and colleagues[36] found that, in a group of 60 individuals with BMI 50–60 kg/m^2 receiving either RYGB or biliopancreatic diversion with duodenal switch, the presence of OBE prior to surgery predicted lower BMI at two and five years following surgery. Several factors may account for this discrepancy, including differences in the surgical procedures under investigation, assessment methodology of OBE, i.e. use of a self-report instrument, the EDE-Q (Eating Disorder Examination- Questionnaire) in the study of Morseth et al. vs. interview-based assessment used in the current study, and control for potential confounders in the current study. More generally, it is possible that difficulties in reliably ascertaining LOC and defining an objectively large amount food for those maintaining a very large body mass, may contribute to the inconsistencies in the literature.

Post-surgery eating-related variables associated with poor weight outcome in this study included the EDE global score (combining restraint, shape concern, weight concern and eating concern subscale scores), hunger, and ≥ monthly LOC eating. The finding that, in the multivariable analysis, post-surgery EDE global score and hunger, but not LOC eating, were associated with weight loss suggests that the association of LOC eating with weight loss in our initial analysis may largely be accounted for by the associations between LOC eating and EDE global score and hunger. However, when interpreting these findings it is important to note that due to the low prevalence of post-surgery bulimia and overeating episode variables, we were only powered to analyze associations with post-surgery SBE and LOC at a threshold of ≥ monthly, which may have detracted from our ability to detect associations. In addition, we lacked power to evaluate post-surgery OBE or OOE at any frequency. Thus, a larger sample is required to evaluate whether bulimia and overeating episodes at greater frequency (i.e., ≥ weekly) is clinically relevant to post-surgery weight loss.

The finding that cravings were weakly associated with greater weight loss, but only in the multivariate analysis controlling both for hunger and global EDE score, must be interpreted with caution. It is possible that the experience of cravings includes some aspects that might be associated with reduced weight loss, such as hunger and pathological attitudes toward eating and weight, as well as other aspects that might be associated with greater weight loss, such as refusal to consume particular foods. Given the complex relationships between cravings and weight loss observed herein, any conclusion regarding their relationship must await replication. It will be important for future research in this area to discriminate carefully between cravings followed by eating vs. cravings that are successfully resisted.

Our findings that post-surgery LOC eating, hunger and eating pathology (as measured by the EDE global score) are related to less weight loss is consistent with the previously reported LABS-3 finding that post-surgery BED, based on DSM criteria, although rare, was related to less weight loss.[22] Taken together, the findings with regard to BED, LOC eating, EDE global score, and hunger in the LABS-3 suggest that the assessment and management of post-surgery eating pathology is of key importance in optimizing weight loss. In particular, the juxtaposition of increasing hunger over the post-surgery period with the predictive significance of post-surgery hunger for less favorable weight outcome underscores the importance of hunger as an indicator to be closely monitored and addressed over the long term following surgery. Replication of these findings would suggest potential targets for education and intervention to mitigate poor outcomes.

There may be a physiological basis for changes in hunger from pre- to post-surgery and during the years following surgery relating to differing effects on neuroendocrine and hormonal factors, bile acid alterations, changes in the microbiome, and other factors.[21] It is of interest in this regard that we did not detect a difference in post-surgery hunger ratings between two very different surgical procedures, LAGB and RYGB. Global eating pathology did show a more favorable response to RYGB vs. LAGB surgery; however, as the EDE global score includes ratings of weight and shape concern, this may reflect differences in weight loss.

The current study has several strengths. The use of the EDE-BSV with multiple frequency thresholds for key variables provides a level of detail regarding eating-related behaviors and experiences that allows for a more nuanced assessment of clinical characteristics that may be associated with surgical weight loss. For example, although this study replicates earlier findings regarding the association of LOC eating and weight loss, the finding that this association is largely accounted for by core eating pathology, as reflected in the EDE global score, and hunger, adds to our understanding of this association. Additional strengths include the size of the cohort, length of follow-up, and separation of research procedures from clinical evaluation. The latter is of particular importance, as lower rates of eating pathology have been reported from programs in which research was not separate from clinical evaluation,[37,38] suggesting patients may underreport symptoms that they fear may adversely affect surgery eligibility.

Several limitations should be noted. First, there is limited racial and ethnic diversity in the cohort. Second, there are limitations related to the need for consensus criteria for disorders of eating such as night eating syndrome and "picking and nibbling," and this may have impacted our ability to detect associations between these phenomena and weight loss. Experiential phenomena such as hunger, cravings, or enjoyment of eating would benefit from assessment via several convergent items rather than a unitary rating. In addition, future studies with larger sample sizes will be needed to detect differences in rates of eating pathology at the highest frequency levels, e.g. weekly or greater, and whether these higher frequencies (vs. lower frequencies) have a stronger association with weight loss. Finally, we note that the EDE-BSV, and the EDE on which it is based, focus the respondent on eating episodes that (s)he considers unusually large. This may divert attention from eating episodes that an individual does not consider large, but are accompanied by a feeling of LOC. Such episodes may be of particular importance for individuals following bariatric surgery whose eating pathology, due to the constraints imposed by the surgical procedures, may be mostly or entirely limited to the consumption of modest amounts of food at frequent intervals.

In summary, pathological eating-related behaviors and experiences generally decrease dramatically following bariatric surgery, and these benefits continue for at least three years following surgery. Although the lack of reliable pre-surgical predictors provides little guidance regarding the selection of individuals for bariatric surgery, the LABS-3 findings reported herein, particularly the associations of post-surgical EDE global score and hunger with less favorable weight outcome, provide potentially important targets for future hypothesis-driven research. Such studies may provide additional much-needed empirical support for interventions to optimize outcome for those most at risk for sub-optimal weight loss or weight regain following bariatric surgery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Source of Funding: This clinical study was a cooperative agreement funded by the National Institute of Diabetes and Digestive and Kidney Diseases (Grant DSS-U01DK066557; Columbia, U01-DK66667), in collaboration with Cornell University Medical Center CTSC (Grant UL1-RR024996], Neuropsychiatric Research Institute (Grant U01-DK66471), and University of Pittsburgh Medical Center (Grant U01-DK66585 [in collaboration with CTRC, Grant UL1-RR0241531]). In addition, this study was funded by the National Institute of Diabetes and Digestive and Kidney Diseases (Grant R01 DK084979). Dr. Kalarchian reports receiving funding for research in bariatric surgery from The Obesity Society/ Nutrisystem and the American Society for Metabolic and Bariatric Surgery. Dr. Devlin reports royalties from Wolters Kluver Health. Dr. Marcus serves on the Scientific Advisory Board of Weight Watchers International, Inc. Dr. Mitchell reports royalties for books from American Psychiatric Press Inc., Guilford, and Routledge.

References

1. Wang Y, Beydoun MA, Liang L, Caballero B, Kumanyika SK. Will all Americans become overweight or obese? Estimating the progression and cost of the US obesity epidemic. Obesity (Silver Spring). 2008; 16:2323–2330. [PubMed: 18719634]
2. Loveman E, Frampton GK, Shepherd J, Picot J, Cooper K, Bryant J, et al. The clinical effectiveness and cost-effectiveness of long-term weight management schemes for adults: A systematic review. Health Technol Assess. 2011; 15:1–182.
3. Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, Schoelles K. Bariatric surgery: A systematic review and meta-analysis. JAMA. 2004; 292:1724–1737. [PubMed: 15479938]
4. Courcoulas AP, Christian NJ, Belle SH, Berk PD, Flum DR, Garcia L, et al. Weight change and health outcomes at 3 years after bariatric surgery among individuals with severe obesity. JAMA. 2013; 310:2416–2425. [PubMed: 24189773]
5. Mitchell JE, Selzer E, Kalarchian MA, Devlin MJ, Strain GW, Elder KA, et al. Psychopathology before surgery in the Longitudinal Assessment of Bariatric Surgery-3 (LABS-3) Psychosocial Study. Surg Obes Relat Dis. 2012; 8:533–541. [PubMed: 22920965]
6. Malik S, Mitchell JE, Engel S, Crosby R, Wonderlich S. Psychopathology in bariatric surgery candidates: a review of studies using structured diagnostic interviews. Compr Psychiatry. 2014; 55:248–259. [PubMed: 24290079]
7. Kalarchian MA, Marcus MD, Levine MD, Courcoulas AO, Pilkonis PA, Ringham RM, et al. Psychiatric disorders among bariatric surgery candidates: Relationship to obesity and functional health status. Am J Psychiatry. 2008; 164:328–334.
8. Mühlhans B, Horbach T, de Zwaan M. Psychiatric disorders in bariatric surgery candidates: a review of the literature and results of a German prebariatric surgery sample. Gen Hosp Psychiatry. 2009; 31:414–421. [PubMed: 19703634]
9. Hayden MJ, Murphy KD, Brown WA, O'Brien PE. Axis I disorders in adjustable gastric band patients: the relationship between psychopathology and weight loss. Obes Surg. 2014; 24:1469–1475. [PubMed: 24570091]
10. Hudson JI, Hiripi E, Pope HG, Kessler RC. The prevalence and correlates of eating disorders in the National Comorbidity Survey Replication. Biol Psychiatry. 2007; 61:348–358. [PubMed: 16815322]
11. Meany G, Conceição E, Mitchell JE. Binge eating, binge eating disorder, and loss of control eating: Effects on weight outcomes after bariatric surgery. Eur J Eat Disord. 2014; 22:87–91.
12. Geliebter A. New developments in binge eating disorder and the night eating syndrome. Appetite. 2002; 39:175–177. [PubMed: 12354686]
13. Schenck CH, Hurwitz TD, O'Connor KA, Mahowald MW. Additional categories of sleep-related eating disorders and the current status of treatment. Sleep. 1993; 6:457–466.
14. Allison KC, Wadden TA, Sarwer DB, Fabricatore AN, Crerand CE, Gibbons LM, et al. Night eating syndrome and binge eating disorder among person seeking bariatric surgery: Prevalence and related features. Obesity (Silver Spring). 2006; 14:77S–82S. [PubMed: 16648598]

15. Rein AK, Mühlhans B, de Zwaan M. Nocturnal eating in obese patients prior to bariatric surgery. Psychother Psychosom Med Psychol. 2007; 57:442–447. [PubMed: 17948208]

16. Colles SL, Dixon JB, O'Brien PE. Grazing and loss of control related to eating: Two high-risk factors following bariatric surgery. Obesity (Silver Spring). 2008; 16:615–622. [PubMed: 18239603]

17. Conceição EM, Mitchell JE, Engel SG, Machado PP, Lancaster K, Wonderlich SA. What is "grazing"? Reviewing its definition, frequency, clinical characteristics, and impact on bariatric surgery outcomes, and proposing a standardized definition. Surg Obes Relat Dis. 2014; 10:973–82. [PubMed: 25312671]

18. Segal A, Kussunoki D, Larino MA. Post-surgical refusal to eat: anorexia nervosa, bulimia nervosa or a new eating disorder: A case series. Obes Surg. 1004; 14:353–360.

19. Marino JM, Ertelt TW, Lancaster K, Steffen K, Peterson L, de Zwaan M, et al. The emergence of eating pathology after bariatric surgery: A rare outcome with important clinical implications. Int J Eat Disord. 2012; 45:179–184. [PubMed: 21495051]

20. Conceição E, Orcut M, Mitchell JE, Engel S, LaHaise K, Jorgensen M, et al. Eating disorders after bariatric surgery: A case series. Int J Eat Disord. 2013; 46:274–279. [PubMed: 23192683]

21. Manning S, Pucci A, Batterham RL. Roux-en-Y gastric bypass: effects on feeding behavior and underlying mechanisms. J Clin Invest. 2015; 125:939–948. [PubMed: 25729850]

22. Kalarchian MA, King WC, Devlin MJ, Marcus MD, Garcia L, Chen JY, et al. Psychiatric disorders and weight change in a prospective study of bariatric surgery patients: A 3-year follow-up. Psychosom Med. In press.

23. Belle SH, Berk PD, Courcoulas AP, Flum DR, Miles CW, Mitchell JE, et al. Safety and efficacy of bariatric surgery: Longitudinal Assessment of Bariatric Surgery. Surg Obes Relat Dis. 2007; 3:116–126. [PubMed: 17386392]

24. Flum DR, Belle SH, King WC, Wahed AS, Berk P, Chapman W, et al. Perisurgery safety in the longitudinal assessment of bariatric surgery. New Eng J Med. 2009; 361:445–454. [PubMed: 19641201]

25. Belle SH, Berk PD, Chapman WH, Christian NJ, Courcoulas AP, Dakin GF, et al. Baseline characteristics of participants in the Longitudinal Assessment of Bariatric Surgery-2 (LABS-2) study. Surg Obes Relat Dis. 2013; 9:926–935. [PubMed: 23602493]

26. Fairburn, CG.; Cooper, Z. The Eating Disorders Examination. In: Fairburn, CG.; Wilson, GT., editors. Binge eating: nature, assessment, and treatment. 12. New York: The Guilford Press; 1993. p. 317-331.

27. Berg KC, Peterson CB, Frazier P, Crow SJ. Psychometric evaluation of the eating disorder examination and eating disorder examination-questionnaire: a systematic review of the literature. Int J Eat Disord. 2012; 45:428–438. [PubMed: 21744375]

28. de Zwaan M, Hilbert A, Swan-Kremeier L, Simonich H, Lancaster K, Howell LM, et al. Comprehensive interview assessment of eating behavior 18–35 months after gastric bypass surgery for morbid obesity. Surg Obes Relat Dis. 2010; 6:79–85. [PubMed: 19837012]

29. Allison KC, Lundgren JD, O'Reardon JP, Martino NS, Sarwer DB, Wadden TA, Crosby RD, Engel SG, Stunkard AJ. The Night Eating Questionnaire (NEQ): psychometric properties of a measure of severity of the Night Eating Syndrome. Eat Behav. 2008; 9:62–72. [PubMed: 18167324]

30. Christian NJ, King WC, Yanovski SZ, Courcoulas AP, Belle SH. Validity of self-reported weights following bariatric surgery. JAMA. 2013; 310:2454–2456. [PubMed: 24189698]

31. SAS Institute Inc. The mixed procedure: The LSMEANS statement. SAS Institute Inc; Cary, NC: SAS Institute Inc; 2009. SAS/STAT(R) 9.2 User's Guide

32. King WC, Chen JY, Belle SH, Courcoulas AP, Dakin GF, Elder KA, et al. Change in Pain and Physical Function Following Bariatric Surgery for Severe Obesity. JAMA. 2016; 315:1362–1371. [PubMed: 27046364]

33. Edwards D, Berry JJ. The efficiency of simulation-based multiple comparisons. Biometrics. 1987; 43:913–928. [PubMed: 3427176]

34. Coleman KJ, Brookey J. Gender and racial/ethnic background predict weight loss after Roux-en-Y gastric bypass independent of health and lifestyle behaviors. Obes Surg. 2014; 24:1729–1736. [PubMed: 24802770]

35. Livhits M, Mercado C, Yermilov I, Parikh JA, Dutson E, Mehran A, et al. Preoperative predictors of weight loss following bariatric surgery: systematic review. Obes Surg. 2012; 22:70–89. [PubMed: 21833817]

36. Morseth MS, Hanvold SE, Rø Ø, Risstad H, Mala T, Benth JŠ, et al. Self-reported eating disorder symptoms before and after gastric bypass and duodenal switch for super obesity – a 5-year follow-up study. Obes Surg. In press.

37. Rosenberger PH, Henderson KE, Grilo CM. Psychiatric disorder comorbidity and association with eating disorders in bariatric surgery patients: A cross-sectional study using structured interview-based diagnosis. J Clin Psychiatry. 2006; 67:1080–1085. [PubMed: 16889451]

38. Mauri M, Rucci P, Calderone A, Santini F, Oppo A, Romano A, et al. Axis I and II disorders and quality of life in bariatric surgery candidates. J Clin Psychiatry. 2008; 69:295–301. [PubMed: 18251626]

Table 1

Baseline demographic and clinical characteristics of LABS-3 participants included in the analysis sample

	Total (N=183)		RYGB (n=111)		LAGB large band (n=29)		LAGB small band (n=43)	
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Sex *								
Male	31	16.9	20	18.0	10	34.5	1	2.3
Female	152	83.1	91	82.0	19	65.5	42	97.7
Age, years, median (25^{th}, 75^{th} percentile)	46.0	(37.0, 54.0)	45.0	(35.0, 53.0)	48.0	(40.0, 54.0)	46.0	(40.0, 55.0)
Race								
White	169	92.9	103	93.6	26	89.7	40	93.0
Black	12	6.6	7	6.4	3	10.3	2	4.7
Multi-race	1	0.5	0	0.0	0	0.0	1	2.3
Hispanic/Latino ethnicity								
Yes	8	4.4	8	7.2	0	0.0	0	0.0
No	175	95.6	103	92.8	29	100.0	43	100.0
Education								
High school or less	30	17.4	20	18.7	4	16.0	6	15.0
Some college/post high school education	73	42.4	48	44.9	10	40.0	15	37.5
College degree or higher	69	40.1	39	36.4	11	44.0	19	47.5
Drink alcohol regularly								
Yes	10	5.7	6	5.6	2	7.4	2	5.0
No	164	94.3	101	94.4	25	92.6	38	95.0
Body mass index, kg/m^2, median (25^{th}, 75^{th} percentile) *	45.1	(42.1, 50.6)	47.1	(43.0, 51.7)	44.8	(41.8, 48.4)	42.6	(39.8, 44.9)

IQR = interquartile range, RYGB = roux-en-Y gastric bypass, LAGB = laparoscopic adjustable gastric band

* Statistically significantly different by surgical procedure (p<.05).

The number of participants across categories may not sum to the total number of participants due to missing data.

Table 2

Eating pathology and experiences by time point among adults who underwent bariatric surgery (N=183)

	Baseline	Year 1	Year 2	Year 3	Baseline vs Year 1	Baseline vs Year 3	Year 3 vs Year 1
	Modeled % (95% CI)				p-value		
Episodes of Bulimia and Overeating (past 6 months)							
Objective bulimic episodes							
present	30.5 (23.2–37.7)	2.3 (0.0–4.8)	5.3 (1.3–9.2)	3.9 (0.4–7.4)	<.0001	<.0001	0.74
≥ monthly	25.5 (18.6–32.4)	1.4 (0.0–3.4)	3.1 (0.1–6.2)	2.6 (0.0–5.6)	<.0001	<.0001	0.77
≥ weekly	11.6 (6.8–16.3)	1.3 (0.0–3.1)	1.4 (0.0–3.3)	1.6 (0.0–3.7)	0.004	0.01	0.98
Subjective bulimic episodes							
present	26.3 (19.2–33.4)	26.1 (18.9–33.4)	15.1 (9.0–21.2)	9.0 (3.8–14.3)	1.00	0.02	0.001
≥ monthly	18.6 (12.6–24.6)	14.7 (8.9–20.5)	9.2 (4.4–14.1)	7.0 (2.5–11.6)	0.59	0.01	0.10
≥ weekly	6.5 (2.5–10.4)	5.8 (1.9–9.6)	4.0 (0.6–7.4)	4.5 (0.7–8.4)	overall p=0.78		
Loss of control eating							
present	40.4 (32.7–48.1)	25.8 (18.6–33)	15.0 (8.9–21.1)	11.7 (5.8–17.7)	0.004	<.0001	0.01
≥ monthly	29.4 (22.5–36.4)	15.7 (10.0–21.3)	9.0 (4.3–13.8)	9.6 (4.3–14.9)	0.001	<.0001	0.25
≥ weekly	18.3 (12.3–24.2)	6.2 (2.4–10.1)	3.1 (0.1–6.0)	7.0 (2.4–11.7)	0.001	0.01	0.97
Objective overeating episodes							
present	35.1 (27.6–42.6)	2.2 (0.0–4.7)	2.4 (0.0–5.2)	1.9 (0.0–4.6)	<.0001	<.0001	0.99
Compensatory Methods (yes/no in past 6 months)							
Any compensatory method**	6.4 (2.6–10.2)	5.1 (1.5–8.6)	6.2 (2.1–10.4)	6.3 (1.9–10.6)	overall p=0.94		
Night eating (past 28 days)							
Regular evening hyperphagia	16.5 (10.6–22.3)	5.0 (1.4–8.5)	6.2 (2.0–10.4)	5.4 (1.1–9.7)	0.01	0.01	0.99
NES score, mean (95% CI)	13.0 (12.0–13.9)	10.1 (9.3–11.0)	10.3 (9.4–11.2)	10.6 (9.5–11.7)	<.0001	<.0001	0.83
Other eating pathology (past 28 days)							
Picking or nibbling							
present	49.8 (42.0–57.7)	29.5 (22.0–37.1)	35.3 (27.2–43.4)	31.8 (23.0–40.5)	0.001	0.004	0.92
≥ weekly	36.0 (28.6–43.4)	20.2 (13.8–26.7)	21.7 (14.8–28.6)	24.1 (16.4–31.8)	0.003	0.06	0.69
Cravings	35.6 (28.6–43.2)	33.8 (25.8–41.8)	36.8 (28.4–45.2)	22.8 (15.0–30.7)	0.93	0.04	0.047
	Mean (95% CI)				p-value		

	Baseline	Year 1	Year 2	Year 3	Baseline vs Year 1	Baseline vs Year 3	Year 3 vs Year 1
	Modeled % (95% CI)				p-value		
EDE scale scores (0–6 in past 28 days)							
Restraint score	1.2 (1.0–1.3)	1.0 (0.8–1.1)	0.8 (0.6–1.0)	0.8 (0.6–1.0)	0.32	0.01	0.32
Eating concerns score	0.7 (0.5–0.8)	0.3 (0.2–0.4)	0.4 (0.2–0.5)	0.2 (0.1–0.3)	<.0001	<.0001	0.43
Shape concerns score	2.6 (2.4–2.8)	1.5 (1.3–1.6)	1.5 (1.3–1.7)	1.4 (1.2–1.6)	<.0001	<.0001	0.98
Weight concerns score	2.7 (2.6–2.9)	1.7 (1.5–1.9)	1.5 (1.3–1.7)	1.4 (1.2–1.6)	<.0001	<.0001	0.07
Global score	1.8 (1.7–1.9)	1.1 (1.0–1.2)	1.0 (0.9–1.2)	1.0 (0.8–1.1)	<.0001	<.0001	0.12
Experience ratings (0–5 in past 28 days)							
Level of hunger	2.7 (2.5–2.8)	2.0 (1.8–2.2)	2.2 (2.0–2.4)	2.3 (2.1–2.5)	<.0001	0.02	0.01
Level of enjoyment	3.2 (3.0–3.4)	2.8 (2.6–3.0)	2.9 (2.7–3.1)	2.8 (2.6–3.0)	0.003	0.02	0.98

EDE = Eating Disorder Examination, NES = Night Eating Syndrome

* The observed prevalence of objective overeating episodes at baseline was 23.0% at least monthly and 12.0% at least weekly. However, objective overeating episodes with a frequency of at least monthly and at least weekly were too rare at follow-up to model.

** Self-induced vomiting, chewing and spitting, laxative misuse, diuretic misuse or driven exercise. Individual compensatory methods were too rare to individually model.

Table 3

Associations between select pre-surgery eating pathology and experiences and pre-to post-surgery weight loss at years 1, 2 and 3, among adults who underwent bariatric surgery*

	% weight loss		
	n	***β* coefficient (95%CI)**	**p-value**
Objective bulimic episodes ≥ weekly	151	2.0(−1.8–5.7)	0.30
Objective bulimic episodes ≥ monthly	151	−0.7(−3.6–2.1)	0.62
Subjective bulimic episodes ≥ weekly	151	1.0(−4.0–5.9)	0.69
Subjective bulimic episodes ≥ monthly	151	1.8(−1.3–5.0)	0.25
Loss of control eating ≥ weekly	151	2.7(−0.5–5.8)	0.09
Loss of control eating ≥ monthly	151	0.4(−2.3–3.1)	0.78
Objective overeating ≥ weekly	151	−0.8(−4.9–3.2)	0.68
Objective overeating ≥ monthly	151	−1.6(−4.8–1.6)	0.32
Regular evening hyperphagia	151	0.6(−2.9–4.0)	0.75
NES score, per 1 point	151	0.0(−0.2–0.2)	0.80
Picking and nibbling ≥ weekly	151	1.6(−0.9–4.1)	0.22
Picking and nibbling, past month	151	0.2(−2.3–2.7)	0.88
Cravings	150	−1.5(−4.1–1.1)	0.25
EDE global score, per 1 point	151	0.2(−1.5–1.8)	0.86
Level of hunger, per 1 point	150	−0.3(−1.7–1.0)	0.64
Level of enjoyment, per 1 point	150	−1.0(−2.0–0.0)	0.06

NES = Night Eating Syndrome

* A linear mixed model adjusting for site, sex, race, pre-surgery age, BMI, diabetes, hypertension and ischemic heart disease, and surgical procedure was constructed for each eating pathology/eating experience.

Table 4

Associations between post-surgery eating pathology and experiences and pre-to post-surgery weight loss at years 1, 2 and 3, among adults who underwent bariatric surgery*

	% weight loss		
	n	**β coefficient (95%CI)**	**p-value**
Subjective bulimic episodes ≥ monthly	151	−0.5(−2.5–1.6)	0.66
Loss of control eating ≥ monthly	151	−2.1(−4.1–−0.1)	0.04
Regular evening hyperphagia	149	0.2(−2.1–2.5)	0.86
NES score, per 1 point	149	0.0(−0.1–0.2)	0.84
Picking and nibbling ≥ weekly	149	−0.6(−2.3–1.1)	0.48
Picking and nibbling, past month	149	−1.1(−2.5–0.3)	0.11
Cravings	148	0.4(−0.9–1.8)	0.54
EDE global score, per 1 point	149	−2.5(−3.6–−1.4)	<.0001
Level of hunger, per 1 point	148	−1.1(−1.7–−0.4)	0.002
Level of enjoyment, per 1 point	148	−0.1(−0.7–0.5)	0.85

NES = Night Eating Syndrome

*A linear mixed model adjusted for site, sex, race, pre-surgery age, BMI, diabetes, hypertension and ischemic heart disease, surgical procedure, and the pre-surgery value of the corresponding post-surgery eating variable was constructed for each eating pathology/ experience. Objective overeating was too rare post-surgery to model.